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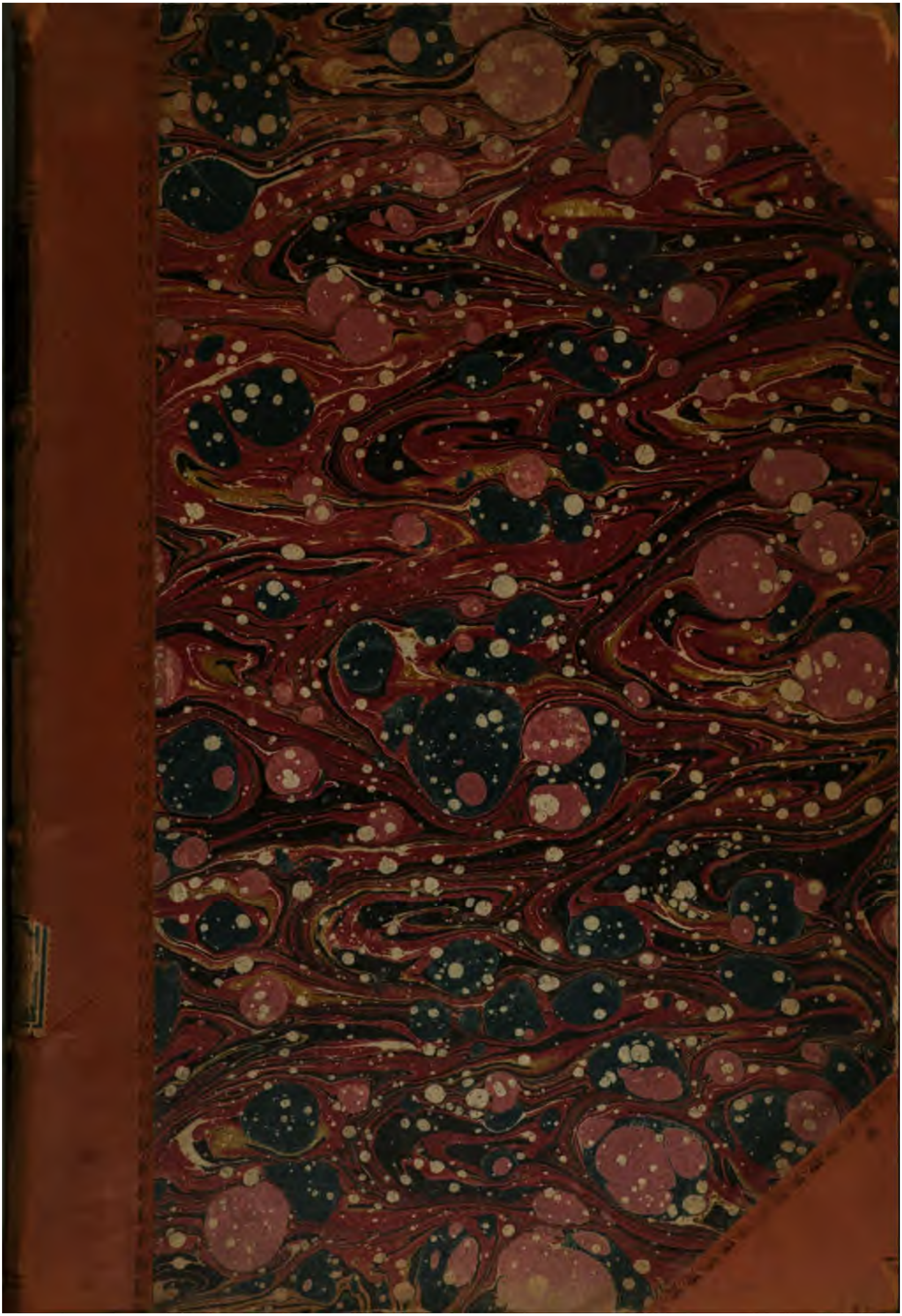

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BODLEIANA BIBLIOTHECA

To
Captn Brown
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Sent Mr Brown
with Augst Delivery
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Gough Adds:

AN
OUTLINE
OF THE
MINERALOGY
OF THE
SHETLAND ISLANDS,
AND OF THE
ISLAND OF ARRAN.

ILLUSTRATED WITH COPPER-PLATES.

WITH AN
APPENDIX;
CONTAINING OBSERVATIONS ON
PEAT, KELP, AND COAL.

BIBLIOTHECA BODLEIANA

BY ROBERT JAMESON,
MEMBER OF THE ROYAL MEDICAL, AND NATURAL HISTORY SOCIETIES,
EDINBURGH; AND OF THE LINNÆAN SOCIETY, LONDON.

> *Obſervationes veras, quam ingenioſiſſimas fictiones ſequi præſtat; Naturæ myſteria potius indagare quam divinare.*
>
> BERGM. DE FORM. CRYSTALLOR.

EDINBURGH:
PRINTED FOR WILLIAM CREECH;—AND T. CADELL, JUN.
AND W. DAVIES, LONDON.
1798.

TO

THE REV. DR. WALKER,

PROFESSOR OF NATURAL HISTORY
IN THE UNIVERSITY OF EDINBURGH,

&c. &c. &c.

THE FOLLOWING WORK IS INSCRIBED,

IN TESTIMONY OF

THE GREAT RESPECT,

AND SINCERE AFFECTION,

OF HIS HUMBLE SERVANT,

THE AUTHOR.

ADVERTISEMENT.

THE AUTHOR regrets extremely, that he is neceſſitated to leave to others, the care of ſuperintending the preſs, during the printing of this work. He is ſenſible that errors may occur, which might have been prevented, had he been himſelf on the ſpot; but he hopes the indulgence of the public will excuſe any little inaccuracy; and he indulges this hope, with the more confidence, when he conſiders that the inveſtigations he is now to be employed in, are of an important and intereſting nature, the Mineral Hiſtory of part of the Hebrides being his principal object.

ERRATA.

In the Introduction p. v. l. 15. for ſuprepoſitions, read ſuperpoſitions.

PAGE 19. laſt word of the note, *for* Emery, *read* Imrie.
20. laſt line, *for* electrial, *read* electrical.
21. after the analyſis, *add*, Water and loſs 4, 9.
32. line laſt but two, *read* pieces.
33. at the end, of the third line, *add* of.
38. in the title, put a comma after Fetlar.
39. line laſt but one, *for* Lamillar, *read* Lamellar.
42. line 6th, *for* loſſes, *read* loſes.
48. line 14th, *for* lies, *read* lie.
52. line 1ſt, *for* ſouth, *read* north.
64. line 5th, *for* ſouth, *read* north.
68. line 2d, *for* Keid-vere, *read* Keid-vore.
99. line 15th, *for* Keid-voe, *read* Keid-vore.
123. line 24th, *for* Glen-Irſa, *read* Glen-Erſay.
125. line 8th, *for* Drumoodon, *read* Drumadoon.
144. line 6th, *for* Lampaduix, *read* Lampadius.
194. line 3d, after Arran *inſert* 3½ lb. and
line 8th, after Leith Shores *inſert* 3 lb.

INTRODUCTION.

MINERALOGY has engaged the attention of mankind, more or leſs, for a long ſeries of ages; but, like moſt other ſciences, has riſen to importance within a few years only. To the labours of the great Werner, we are indebted for the moſt accurate diſcrimination of the ſpecies of foſſils by their external characters; theſe conjoined with the admirable analyſis of Klaproth have enabled us to diſtinguiſh foſſils with certainty, and underſtand the deſcriptions of authors, which could not be done from the vague and contradictory characters of Linnæus, and the other Swediſh mineralogiſts. The want of a true ſyſtematic arrangement is ſtill to be regretted; for although mineralogiſts, from the days of Theophraſtus to the preſent time, have been engaged in this attempt, their ſucceſs has been but limited. In Botany and Zoology, regular methods have been propoſed and followed: in mineralogy, however, the greater number of writers, excepting Linnæus and Dr Walker, have diſcarded the idea of a ſtrict Natural Hiſtory arrangement, from its ſuppoſed inſufficiency. This opinion, there can be no queſtion, is extremely falſe and injudicious; for it will be found upon a ſtrict examination, that foſſils are very ſuſceptible of arrangement into Claſs, Order, Genus and Species; thus giving a fixity and regularity to our information, of which we can have little idea from many of the methods that have been propoſed. It need not be concealed, that in ſeveral inſtances, by joining the external and chemical characters, we will find all our attempts at a ſatisfactory arrangement in vain; this is not, however, an objection more applicable to the Natural Hiſtory than to any of the other methods; for all artificial ſyſtems are, in ſome degree, liable to error. What I here principally allude to, is an obſervation made by an intelligent obſerver and excellent mineralogiſt, Charles Hatchet, Eſq. F. R. S. who very ingenuouſly remarks, that many foſſils, whoſe conſtituent parts are the ſame, and in a ſimilar proportion, have very different external characters, ſo that they have been placed in different diviſions of the ſyſtem. To ſhow that this obſervation is not fanciful, he has numerous intereſting ſeries of foſſils in his cabinet illuſtrating the fact, and has collected the analyſis from different authors, who could not be influenced by ſuch an opinion.

Notwithſtanding this want of accurate and judicious arrangement, mineralogy has been cultivated in ſome countries with the greateſt ardour and enthuſiaſm: but it is to the Germans we owe almoſt the whole of what is known, not only with regard to Mineralogy, but Geology, and that moſt important concern, the working and œconomy of mines. In Germany, many governments have long ſince eſtabliſhed ſchools and boards of mines, and the decided pre-eminence which mining holds in all matters connected with mineralogy, &c. is the beſt proof of the utility of ſuch inſtitutions. This ſcience is now beginning to extend its influence: all nations are following the great example of the Germans: even Portugal, in general little attentive to matters of this kind, has lately ſent ſeveral intelligent men to collect the information of mining countries. England, yielding to none in the other arts and ſciences, is far behind in this reſpect: it is to be hoped, however, that the ardour for uſeful information, which has always characteriſed that country, will ſoon extend its influence to the cultivation of one of the moſt intereſting and uſeful of the ſciences. Ireland, through the labours of its brigheſt ornament, Mr Kirwan, and ſome other diſtinguiſhed patriots, is now enriched with a collection, which will not fail to diffuſe a taſte for ſuch kind of inveſtigations, and will certainly prove of much conſequence to a country whoſe mineral hiſtory, we may ſafely ſay, is utterly unknown. Scotland

land, although rich in mines, and preſenting a great number of promiſing mineral appearances, is but little known. The method of working is, in many places, ill underſtood, and the ignorance of the generality of mine-maſters ſhows the neceſſity of mineralogical ſchools.

The utility of ſuch inſtitutions cannot be doubted: a regular and ſyſtematic courſe of any art or ſcience is always to be deſired: it is from ſuch inſtitutions that accurate and judicious obſervers iſſue, although not there that the moſt important improvements may be made. Mens minds, when once ſtored with the well authenticated information of an able teacher, are more ready in any caſe to apply their knowledge with judgment, and ſhow their ſuperiority over the rude obſerver, who may want or deſpiſe ſuch opportunities. In the art of mining, how many inſtances have we of uſeleſs expence, and ruin entailed upon fooliſh projectors, from a want of proper information? It is upon ſuch occaſions that the diſappointed ſchemer feels his inferiority, and regrets his loſs.

The outline which I now lay before the public may be thought tedious: it is true I have not followed the uſual plan of a *medley*, having adhered entirely to mineralogical obſervation, without deviating, in any inſtance, to general ſubjects, which only diſtract our attention, and pleaſe the fancy, without any real advantage. What I here

I here aim at is to be a faithful narrator of the appearances which nature preſented to my view. This may appear to ſome an eaſy buſineſs: to me it has peculiar difficulties. The obſervance of nature in a cabinet, and among the mountains of a wild country, are very different employments: in this laſt, not only the multiplicity of the appearances, the wonderful and tremendous ſcenery, but the frequent occurrence of ſtorms, and the obſcurity which nature, by theſe means, throws over the moſt intereſting productions, make us liable to error, notwithſtanding our greateſt care and attention. To conclude, when it is conſidered that, in ſuch ſituations, we are often obliged to examine, not only the different mineral ſubſtances, but alſo their numerous gradations, the poſition of ſtrata with their various turnings and ſuprepoſitions, I hope theſe ſheets will not be viewed with the eye of ſevere criticiſm, but with that indulgence which one naturally claims, whoſe chief appeal to an impartial public is this, that theſe are the notes of one young in a ſcience, in which the moſt experienced of its votaries are often embarraſſed.

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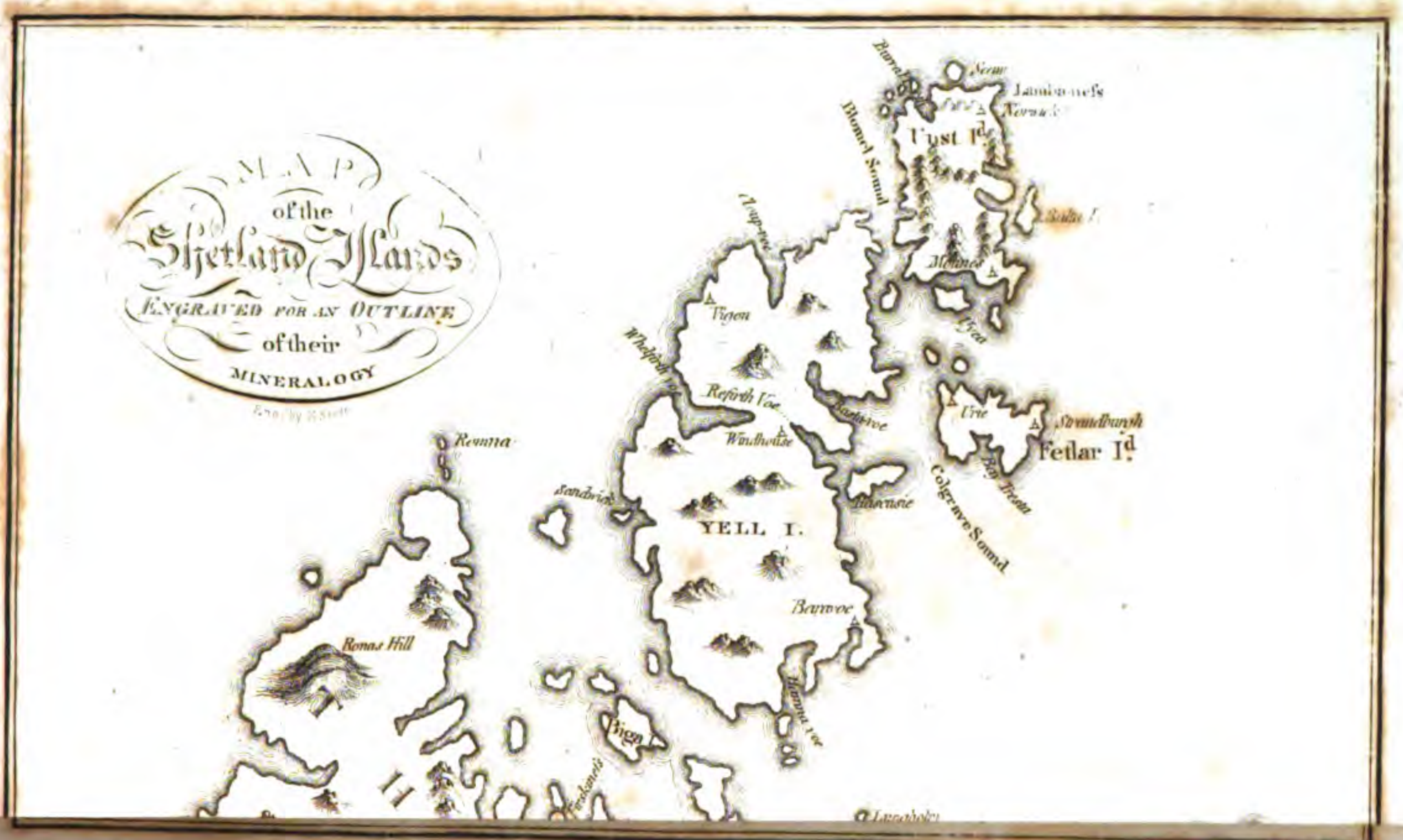
MAP
of the
Shetland Islands
ENGRAVED FOR AN OUTLINE
of their
MINERALOGY
Eng. by R. Scott
Burrafirth
Scaw
Lamba-ness
Norwick
Unst Id.
Blomel Sound
Balta I.
Mounes
Uyea
Urie
Strandburgh
Fetlar Id.
Bay Tresta
Colgrave Sound
Basta-voe
Hamnavoe
Cloup-voe
Tigon
Whelfirth voe
Refirth Voe
Windhouse
Sandwick
YELL I.
Burravoe
Hamna voe
Reunna
Ronas Hill
Bigga
Lunna Holm

SHETLAND ISLANDS.

CHAP. I.

SITUATION, GENERAL APPEARANCE, WESTERLY ELEVATION OF THE MOUNTAINS; MOUNTAINS RUN IN THE LONGEST DIRECTION OF THE ISLANDS; CLIMATE.

THE SHETLAND ISLANDS lie north eaſt from Orkney, between lat. 59° and 61°. The neareſt are diſtant from the Buchan-neſs, forty-ſix leagues; ſixteen or eighteen leagues north from the iſland of Sanda, one of the Orkney iſlands; ſix or ſeven leagues north eaſt from the Fair iſland; fifty-eight leagues eaſt from the Faroe iſlands, and nearly the ſame diſtance north-weſt from the Lewis.

Theſe iſlands are very numerous, but few of them of any conſiderable magnitude; thirty-three are ſaid to be inhabited, of which the largeſt is the Mainland.

On viewing theſe iſlands in general, a wonderful ſcene of rugged, bleak, and barren rocks preſents itſelf to our view. No tree or ſhrub is to be ſeen to relieve the eye in wandering over theſe dreary ſcenes. Sometimes, however, a few ſcanty portions of cultivated ground, catch the eye of the traveller, exciting emotions of pleaſure, and forming a ſtriking contraſt to the barren heath-covered mountains which ſkirt them. The weſtern part preſents many ſcenes, as wild and ſterile as can well be conceived; grey rocks, riſing from the midſt of marſhes or pools, and ſhores bounded by awful ſea-beat precipices, do not fail to raiſe in the mind ideas of deſolation and danger.

The coaſts are in general rugged and precipitous, preſenting in many places, ſcenes truly grand and magnificent; vaſt rocks of various heights, dreadfully rugged and broken, oppoſing their rude fronts to all the fury of a tempeſtuous ocean; which in ſome places has formed great detached pillars, in others has excavated grand natural arches and caverns, that mock all human magnificence, and ſtrike the beholder with that awe and wonder, which muſt affect every one on viewing theſe amazing wrecks of nature.

The eaſt ſide of the Mainland, as is alſo the caſe in the other larger iſlands, is comparatively low, but on the weſt is remarkably lofty, rugged, and broken, and many of the mountains are ſenſibly more ſteep on the weſt, than on the eaſt ſide. This geological fact, was firſt remarked by Dr Walker, Profeſſor of Natural Hiſtory, in the Univerſity of Edinburgh. It firſt occurred to him in the hills in the vicinity of Edinburgh; but he alſo found it to hold true in the Lomons, and in all the other hills in the Highlands of Scotland. We alſo know that the weſt coaſts of Scotland and England, have a gradual ſlope towards the eaſt, and the courſe of all the great rivers, as the Spey, Tay, Tyne, Trent, and Thames, is from weſt to eaſt. Upon examining other countries the ſame phenomenon preſents itſelf. Thus, the weſt coaſts of Norway are precipitous, high and rocky; in the interior of Norway, the Lapland Alps preſent a precipitous weſt ſide, and the eaſt ſhelves away, forming extenſive plains. It is alſo very remarkable in the continent of America; where we obſerve ſeveral of the largeſt rivers, as St Laurence, La Plata, and the Amazons, running nearly from weſt to eaſt.

Another obſervation may be made with regard to the hills; that is, that they all run in the longeſt direction of the iſlands in which they are placed. This is a general rule to be obſerved over all the globe. Thus the mountains in Britain run from North to South, the Scandinavian mountains follow the ſame direction, as alſo the great ridges of the Norwegian and Swediſh alps. In America, the long extended chain of the Andes runs from North to South, which is the greateſt length of the continent.

The hills have ſeldom the ſtrikingly rugged aſpect of thoſe in the iſland of Arran, being greatly lower, and not ſo much worn by the rains and torrents; the principal effect of the Shetland ſcenery being that produced by the action of the waves upon the ſea coaſt.

The hills are generally round backed, running in ridges; ſome approach to the conical, and are detached. None are remarkably high; as the higheſt, which is Ronas Hill, is only about fifteen hundred feet above the level of the ſea.

To make general obſervations upon the climate of a country, requires a long and careful ſeries of obſervations, with a multiplicity of apparatus, which few have an opportunity of obtaining. A good deal however may be done by means of careful obſervation with the thermometer and barometer; but even the proper uſe of theſe requires no common ſhare of ſkill. To the exertions of the celebrated Mr Kirwan of Dublin, we are indebted for a great deal upon this ſubject; with a liberality that characteriſes a great mind, he has at great expence diſtributed meteorological inſtruments through Ireland, and we are now beginning to ſee the good effects of ſuch endeavours. In this diſtant quarter of the globe no accurate regiſter of the weather has been kept, ſo that all I can do, will be to make a few general obſervations, which nearly apply to all the Northern Iſles of Britain.

The weather is extremely variable, being much incommoded with rains and thick fogs; which occaſion many veſſels to be wrecked on theſe terrible ſhores. During the winter there are conſiderable falls of ſnow, which lies but a ſhort time, on account of the vicinity of the ſea. The froſts which are ſeldom ſevere, and never long, produce little inconvenience; but were they to continue for any conſiderable length of time, it would be heaping horror upon horror, and would render a ſituation already dreary, comfortleſs. Frequently, during the winter, dreadful ſtorms prevail, particularly from the weſt, which are accompanied with thunder and lightning; an appearance ſeldom obſerved at that ſeaſon in other parts of Britain.

The aurora borealis, or what are uſually called ſtreamers, illuminate the ſky with uncommon brilliancy, and help greatly to alleviate the gloom of the long winter nights.

CHAP.

CHAP. II.

MINERALOGY OF THE MAINLAND.

THIS is by far the largeſt of the Shetland iſlands, being about ſeventy miles long, and from twenty to half a mile broad. So great a difference of breadth naturally ſuggeſts an enquiry into the cauſe, which we diſcover to be the Atlantic Ocean, whoſe powerful tides and waves demonſtrate in awful characters its ſtupendous operations. In ſome places it has carried away great portions of land, connecting the remainder by narrow necks to the Mainland; in others it has acted more equally, forming long narrow tracts connected to the Mainland by ſhort iſthmuſes. Thus at Maviſgrind, the mountainous pariſh of North Mavin is connected to the mainland by an iſthmus about half a mile broad; a ſimilar appearance occurred in the pariſh of Æthſting; and at Quarf, the long narrow tract comprehending the pariſhes of Dunroſſneſs, Sandwick, and Coningſburgh, is joined to the mainland by an iſthmus about two miles broad.

The cliffs around the whole iſland are very rugged, but more ſo on the Weſt than the Eaſt ſide, and the bays or voes, iſlands and rocks, are alſo more numerous on the Weſt than on the Eaſt coaſt.

There are few mountains of any conſiderable height, being generally from a thouſand to fifteen hundred feet high. Few of them are unconnected, but generally run from North to South in the form of chains, having round-backed ſummits, approaching more or leſs to the conical form. Several conſiderable ridges can be traced along the whole of their courſe, and of theſe the moſt remarkable are the following:

1. Cliff Hills. This range commences oppoſite to the iſland of St. Ranens, where it is of

conſiderable height, running by Scalloway to Deal Voe, and from that to the ſea, where it becomes gradually lower.

2. This range (which has no particular name) riſes from Weſtſhore, runs South Weſt and North Eaſt to Lunneſting, terminating on the ſea-ſhore; with little variation of height.

3. This range riſes upon the Eaſt ſide of Weeſdale Voe from Buneneſs, and runs from ſixteen to eighteen miles, terminating on the ſouth ſide of Deal Voe in the pariſh of Delting.

4. This range, which is the higheſt, riſes from the Weſt ſide of Weeſdale Voe from Ruſtaneſs, and terminates at Firſkineſs in Delting.

Having now mentioned the principal ranges of hills, and other preliminary facts, I proceed to the conſideration of the mineral hiſtory of the iſland in particular; but previous to this I ſhall make a few remarks upon the plan I mean to adopt. In writing the mineral hiſtory of any country, various plans have been followed; but theſe uſually depend more upon the degree of information the author is poſſeſſed of, than a predilection for any peculiar ſpecies of writing. Thus a thorough examination of all the ſtrata of a certain diſtrict, their peculiarity of form, ſituation and compoſition, is beſt detailed in the form of a hiſtory; whereas a ſuperficial and leſs ſatisfactory examination is uſually related in the manner of a journal. Of mineralogical hiſtories, however, there are but few, excepting ſome diſquiſitions by German authors; nor is this to be wondered at, conſidering the infant ſtate of the ſcience, and the great labour attending inveſtigations of this kind. It is not ſufficient that we obſerve a ſtratum as we paſs along, and remark its appearance again in ſome diſtant quarter; but we muſt trace it from its commencement, through all its various turns to its termination, aſcertaining at the ſame time its connection with others, their mutual gradations, with many other general and particular obſervations, which require a long and careful inveſtigation. On the other hand, Mineralogiſts, in travelling through undeſcribed countries, have given much uſeful and intereſting information in the form of a journal; thus Sauſſure, Charpentier, Ferber and others, have in this way detailed a great number of facts, and diffuſed a very conſiderable taſte for enquiries of this kind.

In the Outline I am now to give of the Shetland iſlands, and the iſland of Arran, I find it convenient to follow nearly the method of a journal, as beſt ſuited to the general view I am to take.

The Mainland is divided into ſeveral pariſhes, and ſome of them are of conſiderable extent; the pariſh of Lerwick, which gives name to the principal village in the iſland, is the ſmalleſt. This village contains about two thouſand inhabitants, and is built upon the ſhore of Braſſay ſound, which is about the middle of the iſland. The houſes in general are but indifferent; here and there, however, there are ſome commodious dwellings, and they are built of ſandſtone, and ſandſtone breccia, forming one ſtreet, which is terminated by Fort Charlotte. This fort was built during the time of Oliver Cromwell, and was for a long time in a ſtate of ruin, until lately that it has been repaired at great expence, and garriſoned by a corps under the command of Captain ——.

Braſſay Sound, which is the harbour of Lerwick, is one of the moſt extenſive and ſafe harbours in the Britiſh dominions, and has its name, and is formed in part by the iſland of Braſſay. This iſland is about five miles long, and between two and three broad, but very irregular in its ſhape. It is high and rugged on the South and Eaſt, where it is much expoſed to the action of the ſea, but it is comparatively low on the Weſt and North, where it forms part of the ſound. The higheſt hill which is called the Ord of Braſſay, forms, towards the ſea, frightful precipices ſeveral hundred feet high, all compoſed of ſandſtone, ſlaty ſandſtone, ſandſtone flag and breccia, and the whole iſland is compoſed of the ſame materials. A great maſs has been ſeparated from the eaſt ſide by the violent action of the ſea, and forms what is called the iſle of Noſs, remarkable for its tremendous cliffs and holm, where the natives encounter many dangers in fowling. This famous holm* is ſeparated about 34 fathoms from the iſle, and is perfectly mural on all ſides, ſo as to preſent a moſt terrific aſpect when viewed from below. Inacceſſible as it appears, it has not prevented the daring iſlanders from gaining its ſummit, which exploit was performed many years ago, by a dauntleſs fowler, who, having climbed to the top, drove ſtakes into the ground, and ropes being thrown around them from the oppoſite ſide, were faſtened to correſponding ſtakes upon the bank of the iſland. A machine of wood, which they call a *cradle*, was then faſtened upon the ropes, ſo that it could be pulled backwards and forwards, and in this way they go in queſt of the numberleſs ſea-fowl that inhabit theſe cliffs. The fowler who firſt planted the ſtakes, fluſhed with his ſucceſs, would not take the advantage of the cradle; but braving every thing, attempted to deſcend, when he was daſhed to pieces upon the rocks below. The iſland and the Holm do not differ from Braſſay in their compoſition, being formed of ſandſtone,

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* Mr Pennant in the elegant introduction to his Arctic Zoology, has given a drawing of Lows, which expreſſes the appearance of the Holm very indifferently. The holm is ſaid, by Mr Pennant, to be about 480 feet in height; this is certainly too high.

ſandſtone flag, and breccia; but the ſandſtone is of various colours, a conſiderable extent of the cliffs being of a reddiſh hue.

The oppoſite ſide of the ſound where Lerwick is ſituated, is compoſed of the ſame ſandſtone and breccia, which we obſerve at Braſſay. The Fort already mentioned, forming one extremity of the town, is built upon a rock of breccia, which ſoon diſappears, when a horizontal ſtratum of ſandſtone takes its place, running to the oppoſite extremity of the town called the Nab. The hills in the neighbourhood are not high, and are compoſed of ſandſtone and breccia. This ſandſtone is the ſame we obſerve in all the other parts of the iſland. It is the Sympexium of Dr Walker, the Argillaceous ſandſtone of Mr Kirwan; is of various colours, and of the uſual hardneſs of common building ſtone. The breccia is a curious compound, being formed of red granite, micaceous ſhiſtus, quartz, feltſpar, and green mica; the fragments are either rounded or angular; of various ſizes, from that of a grain, to maſſes of ſeveral hundred weight. The ſubſtramen or baſis is hardly diſcernible, excepting when the maſſes are large, when a paſte is formed by the ſmaller fragments. I alſo obſerved in general, that where the fragments are large, the ſtrata are diſtinguiſhed with difficulty, and are horizontal; but as the particles become ſmaller, the ſtrata are more diſtinct and inclined.

The coaſt from Lerwick to Quarf is compoſed of ſandſtone; in ſome places however, there are great rocks of breccia, which have a very ſingular appearance, owing to the immenſe ſize of the concretions. On this part of the coaſt there are ſeveral extenſive caves; we rowed a conſiderable way into one of them, then landed and walked to its further extremity. At the entrance it has the appearance of a natural arch, which becomes gradually lower until it is loſt in darkneſs, where nothing is to be heard but the dropping of water from the damp black roofs, and now and then the ſilence is diſturbed by the ſnorting of ſeals, or the flutter of the Pelicani or Columbæ. But the moſt beautiful part of theſe rocky ſcenes, is the wonderful tranſparence of the water, which diſcloſes to our view, rocks of various fantaſtic forms, covered with the beautiful Millepora rubra, adorned with fuci of a great variety of colours. Theſe by the gentle motion of the water diſcover numerous ſpecies of Spongiæ, Actiniæ and Echini, of the moſt exquiſite colours, altogether forming an admirable ſubmarine picture.

At Quarf, the iſland is only about two miles broad, forming the iſthmus which connects the ſouthern pariſhes with the Mainland, and is bounded on both ſides by mountains of conſiderable height, compoſed of micaceous ſhiſtus. Here there is a ſmall fiſhing ſtation, from which boats go to the *Haaſe*, or fiſhing ground, in ſearch of tuſk and ling.*

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* The fiſheries of this country, have been often the ſubject of diſcuſſion, but the ſtate of the lower orders has hardly touched the heart of the traveller. It is foreign to my preſent purpoſe, but worthy of an abler pen, to ſet in a proper point of view, the miſeries and the deplorable ſtate of our countrymen in that quarter.

> But Oh! what crowds, in every land,
> Are wretched and forlorn;
> Thro' weary life this leſſon learn,
> That man was made to mourn.
>
> BURNS.

The land from this again becomes broader, forming one ſide of Æthvoe, and is all compoſed of ſandſtone, and breccia; in ſeveral places, however, there are conſiderable ſtrata of limeſtone, which is worked for building, and manuring the ground. This voe is a large open bay, having the flat and cliffs of Coningſburgh on the north and weſt, with Sandlodge, and Mouſa on the ſouth. The cliffs of Coningſburgh, which form part of the range of hills that riſe oppoſite to St. Ranens, are compoſed of micaceous ſhiſtus,* of various ſpecies, more or leſs penetrated with quartz, having the ſandſtone lying upon it, which ſhows in a diſtinct manner the junction of the primary and ſecondary ſtrata. In ſome places the ſea has carried away the ſandſtone, and left the micaceous ſhiſtus expoſed; and where there has been an unequal action of the ſea, the micaceous ſhiſtus is to be ſeen riſing through the ſandſtone. This laſt circumſtance has frequently deceived obſervers, particularly in their examination of ſtrata, which have been expoſed to the action of the waves of the ocean. Thus, at that intereſting ſpot, Portſoy, we obſerve the Serpentine lying upon the Granite in a very diſtinct manner; but where the rocks have been much expoſed to the action of the ſea, conſiderable portions of the Serpentine have been carried away, leaving the projecting maſſes of Granite, ſometimes in the form of great veins running through the Serpentine, or large maſſes ſeemingly lying over it.*

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* The term Shiſtus has been much extended in its ſignification, particularly by a late celebrated Theoriſt, who includes, under this name, Gneiſs, Micaceous ſhiſtus, Chlorite ſhiſtus, Hornblende ſhiſtus and Ardeſia. This want of accuracy is to be regretted; for it is plain, if ſuch confuſion be ſanctioned, that the ſcience of mineralogy will revert to the unmeaning jargon of a Sir John Hill.

Amongſt theſe rocks I obſerved beautiful ſpecimens of the *Sappare Dure*, a foſſil which has been lately examined by the young Sauſſure. It was immerſed in a compact ſpecies of micaceous ſhiſtus, and preſented the following external character.

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[*] Theſe particulars are well marked in ſeveral beautiful drawings of Portſoy, in the poſſeſſion of Lieut.-Colonel Emery.

Colour.—White, finely tinged with azure blue. The detached cryſtals reflect a ſilver white light, but not ſo bright as the Adularia, when a little decompoſed.

Cryſtallization.—Is cryſtallized in the form of compreſſed priſms, interſected more or leſs with tranſverſe ſections, and preſenting two narrow and ſlightly ſtreaked, and two broad and ſmooth ſides. The cryſtals are frequently diſpoſed in a radiated form.

Croſs fracture.—Striated and deſtitute of luſtre.

Longitudinal fracture.—Foliated with a luſtre like that of cryſtals, and metals not much poliſhed.

Hardneſs—when ſtruck parallel to its length, yields difficultly to the knife; when perpendicular to its length, gives fire with ſteel; ſcratches glaſs.

Specific gravity, 3. 618.

Becomes electrial by friction, and this electricity is negative. Sauſſure, in his excellent analyſis found it to contain, in the hundred parts,

Argill,	55.
Silex,	29, 2.
Lime,	2, 25.
Magneſia,	2, 0.
Iron,	6, 65. †

Having paſſed theſe cliffs we come to Sandlodge, one of the ſeats of the ancient and moſt hoſpitable family of Bruce, of Sumburgh, which is ſituated upon the ſea ſhore; having a pretty extenſive flat near it. At a little diſtance from the houſe, in the ſandſtone, which is here ſtill continued, there is a vein of copper pyrites, or ſulphuret of copper, which was worked for ſome time, by a party of miners, from Wales, with very flattering proſpects; but the vein gradually decreaſed in width, until it was not above an inch broad, when it was thought proper to leave it. This ore afforded me eighteen per cent. of pure malleable copper, by eſſaying according to the method of Eſchaquart, or rather Gerhard.[†] On the oppoſite ſide of the houſe there is a large vein of iron ore, above ſix feet wide, having a very ſcorified aſpect, and containing much manganeſe. It was alſo worked for ſome time, but the great expence, and the ſmall proportion of iron obtained, ſoon cauſed it to be given up. The ſandſtone continues from this, all around to the bay of Sandwick, here and there interſected with calcareous ſpar, and much impregnated with oxyd of iron. Betwixt the Sandlodge and Sandwick bay, lies the ſmall iſland of Mouſa, or Queen iſland, about a mile and a half long, and upwards of a quarter of a mile broad. It is rather low, compoſed entirely of ſandſtone, and ſandſtone flag, with ſeveral ſtrata of limeſtone, which run in the ſandſtone from eaſt to weſt.

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† Mr Herman in the 1. Chym. An: 1793.—p. 394, deſcribes a cryſtallized ſappare, found in Siberia, which differs conſiderably, both in external and chemical characters, from this ſpecies.

The whole coaſt from Sandwick to Sumburgh head, the moſt ſouthern point of the iſland, is almoſt entirely compoſed of ſandſtone, and breccia, lying upon the mountains of Gneiſs and micaceous ſhiſtus, which run through this part of the iſland; and alſo in ſeveral places there are conſiderable ſtrata of limeſtone. From Sumburgh head, which is entirely compoſed of ſandſtone, we have an extenſive and beautiful view of a great part of the Mainland, iſland of Braſſay, and ſtupendous Noſs; on the one hand the far diſtant Fair iſle riſes gently in the horizon, and on the other the ſecluded Fula forms a tremendous object. Below us we have a direful example of the blowing of looſe ſand or what is called the *Sand Flood*; for an eſtate which belongs to Sinclair of Brue is now rendered a forlorn waſte, although, before this calamity, it was one of the moſt productive parts in the iſland. I could not learn the cauſe of this diſaſter, but it was probably owing to the tearing up ſome of the plants which are known to prevent the blowing of ſand. This practice cannot be too ſeverely reprobated, when it is known that the conſequences are ſo pernicious; thus, in many of the Weſtern Iſlands Dr. Walker has obſerved, that if the ſmalleſt aperture be made in the ſand, the flood inſtantly commences; and we know that, in Suffolk, a quantity of ſand, which at firſt only covered about ten acres, has now ſpread itſelf, and covers ſeveral thouſands The ſowing of plants, which grow in looſe ſand, is the only remedy which can be recommended to ſtop the baneful progreſs of thoſe floods, and of theſe ſeveral have been recommended; but the moſt efficacious are the Galium luteum, Elymus arenarius, Triticum junceum, and Arundo arenaria; this laſt the Dutch plant with great benefit. From Sumburgh head acroſs the large open Quendal bay, little is to be ſeen, except a few rocks of an extremely coarſe breccia, of the common kind. At the next head-land, Fitful head, the primary mountains make their appearance, without any covering of the ſecondary breccia or ſandſtone, which diſappears at one ſide of Quendal bay, and is not to be obſerved again until we come to Sandneſs hill on the North Weſt. This immenſe head-land is almoſt entirely compoſed of a lead-coloured micaceous ſhiſtus, of which the greater part is mica, in ſuch minute ſcales as not to be diſtinguiſhable, but in forming large plates. In the fiſſures of the micaceous ſhiſtus I obſerved ſeveral ſmall portions of micaceous iron ore, which for ſome time amuſed a party of miners with hopes of immenſe wealth. The micaceous ſhiſtus is here to be obſerved paſſing to chlorite ſhiſtus, and intermixed with the talcite of Mr Kirwan, the lepis of Dr Walker, and conſiderable quantities of quartz. Below this at Garthſneſs, there is a large vein of ſulphuret of iron, about ſeven feet thick, running in a ſtone intermediate between micaceous ſhiſtus and chlorite ſhiſtus. It lies expoſed to the day for twenty or thirty feet, and was worked for ſome time, but was ſo unproductive that it was ſoon given up.

[†] Kirwan's Mineralogy, vol. 2d. p. 373.

The coaſt from this all along the weſt ſide by Bigtoun to Scalloway, including Colſa iſle, and the iſland of Saint Ranens, is compoſed of granite, micaceous ſhiſtus, chlorite ſhiſtus, talcite of Mr Kirwan and quartz. The granite is by no means of the ſame ſpecies, but is conſiderably varied, of which the following deſcriptions will afford a ſufficient proof.

1. **WHITE COMPACT GRANITE.** Is compoſed of white coloured feltſpar, quartz, with a few ſcales of green mica; the quartz and feltſpar are amorphous, and very cloſely connected, rendering the whole ſo very compact as to give the aggregate a nearly uniform fracture.

2. Red compact Granite. Is compoſed of red feltſpar, green actynolite, with a ſmall proportion of quartz. The feltſpar compoſes about three fourths of the whole, forming altogether a very compact, hard, and not eaſily decompoſible compound.

3d Species. Is compoſed of regularly cryſtallized rhomboidal red coloured feltſpar, with a ſmall proportion of amorphous quartz, and mica in ſcales; forming an aggregate which is not ſo hard or compact as the preceeding ſpecies.

The iſland of Saint Ranens is but ſmall, very rugged, and is connected to the Mainland by a bank of decompoſed micaceous ſhiſtus. Captain Preſton, in his chart of the Shetland Iſlands, has placed this bank at one end in place of the middle. The coaſt from this to Cliff Sound is very rugged, owing to its expoſure to the Atlantic Ocean; but in the Sound the land is defended by the iſlands of Houſe, Burra, and Trondray, and is neither rugged nor very abrupt.

The iſland of Houſe is about three miles long, narrow and flat, compoſed of micaceous ſhiſtus, granite and quartz. Near to the north end I obſerved a remarkable appearance, which although it may be common in other countries, I have ſeldom heard of. It is a vein of granite two or three feet wide, running in the micaceous ſchiſtus; the granite had the uſual appearance, and where in contact with the ſtratified matter was not at all altered in hardneſs. This appearance has alſo been remarked by the celebrated Sauſſure whilſt travelling in the Alps, in the neighbourhood of Mont Buet, alſo near the city of Lyons.* The late ingenious Dr. Hutton of Edinburgh, in his theory of the formation of ſtrata, imagines that this is a proof of the poſterior origin of granite to micaceous ſhiſtus. Such an explanation would anſwer well enough, if the previous ſteps of the theory upon which it is founded, were ſufficiently incontrovertible; as this is not the caſe, we muſt ſtill conſider the granite and micaceous ſhiſtus of coeval formation.

The iſland of Burra, which is ſeparated from the

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* Sauſſure, Voyage dans les Alpes. Octavo edition, Vol. II. Sect. 599,601.

iſland of Houſe by a ſmall ſound, is alſo more rugged on the weſt, where it is much expoſed to the action of the ſea, and is compoſed of granite, micaceous ſhiſtus and quartz.

The coaſt and hills from Scalloway by Uſtneſs Voe, Stromneſs Voe to Wiſdale Voe, are compoſed of the uſual alpine rocks. At Wiſdale Voe there is a great ſtratum of limeſtone, which can be traced for ſeveral miles running in the micaceous ſhiſtus. All the hills in the neighbourhood are compoſed of micaceous ſhiſtus, talcite and gneiſs; this laſt by decompoſition forms a clay-like maſs, which the inhabitants uſe for fullers earth. A great ſection of the gneiſs is to be ſeen amongſt theſe hills, where it is to be obſerved in various ſtages of decompoſition.* It would be curious to determine with certainty, whether or not the diſintegration of the gneiſs depends on the decompoſition of the feltſpar alone, or of the feltſpar, quartz and mica conjointly. From Weeſdale through Æthſting and Sandſting, the alpine rocks continue, forming in many places conſiderable hills, and upon the ſea-ſhore immenſe precipices of red granite. The ſcenery upon this coaſt is awfully grand; let us conceive to ourſelves a great extent of coaſt, dreadfully rugged and broken, preſenting to our view vaſt detached pillars, and numberleſs magnificent arches, through which the tides ruſh with inconceivable fury, and the whole being tinged with a reddiſh hue, produces a moſt terrific ſcene, when contraſted with the lurid appearance of a ſtormy ſky.

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* The late Mr Wedgewood, upon analyzing an earthy ſubſtance from Sidney Cove, New Holland, was led from ſeveral circumſtances to conclude, that it contained a new earth which he called Sydneia. Lately, however, Mr Hatchet, in an excellent paper read to the Royal Society of London, has demonſtrated, in a moſt ſatisfactory manner, that this ſuppoſed earth is a compound of Silex, Argill, and Oxyd of Iron; and he ſuppoſes that it is derived from a decompoſed granite, or gneiſs, ſimilar to what has been mentioned above.

The next pariſh, which is named Walls, I had but little opportunity of examining, ſo that I can ſay nothing with certainty of its compoſition. In the neighbouring pariſh of Sandneſs, the ſandſtone again makes its appearance at Sandneſs hill, which is of conſiderable height. From this the coaſt becomes gradually lower, where it is in many places peculiarly ſterile and iron-like; the land again riſes in height, and ſo on alternately all around the iſland, forming many conſiderable voes, with very magnificent pieces of ſcenery, particularly the Doreholm off the pariſh of North Maving, which is a vaſt detached rock, perforated by a great natural arch, very ſimilar to ſome of thoſe obſerved by Captain Cook amongſt the South Sea iſlands. The immenſe rocks the Oſſa, Skerries and Ramna Stalks, preſent a moſt frightful and tremendous appearance in ſtormy weather; but to particularize the many aſtoniſhing ſcenes that occur around this iſland, would be foreign to my preſent purpoſe. I ſhall therefore conclude this ſketch by remarking that the rocks (as far as I have examined) are either granite, gneiſs, micaceous ſhiſtus, chlorite ſhiſtus, or ſandſtone, but I did not obſerve this laſt in any quantity till we came to the Eaſt coaſt.

CHAP.

CHAP. III.

ISLANDS OF FOULA, PAPA STOUR, VEMENTRY, AND MUCKLE RHOOE.

FOULA.

THIS iſland is about three miles long, and half a mile broad, ſituated in the Atlantic ocean, about twenty-four miles from the Mainland, holding the ſame ſituation with regard to Shetland, as St Kilda does to the Hebrides. It contains but little level ground, being chiefly formed by three hills of a nearly conical ſhape; the higheſt of theſe being between eight and nine hundred feet. Here there is but one landing place, and in bad weather it cannot be approached. The eaſt ſide which is much lower than the weſt, is compoſed of granite, micaceous ſhiſtus, and quartz. The micaceous ſhiſtus covers the granite, but in ſome places the ſea has waſhed it away, and left the granite expoſed, which is of a red colour, and frequently penetrated with veins of quartz. The micaceous ſhiſtus alſo contains neſts of green actynolite, and garnets are often diffuſed through it. The ſouth, weſt, and north ſides of the iſland are compoſed of ſandſtone, and ſandſtone flag, of the ſame ſpecies with that we have obſerved in other parts of Shetland. Upon the weſt ſide there are moſt hideous precipices, inhabited by numberleſs ſea-fowl, which the inhabitants run incredible riſks in catching.

The account which the excellent Biſhop Pontopiddan has given of the fowlers in Norway, is realized and even exceeded by the inhabitants of this ſecluded ſpot. It is not many years ſince it was a common obſervation, that few died a natural death, being either drowned or daſhed to pieces amongſt theſe terrible precipices: now they are more cautious, and comparatively few are deſtroyed.

PAPA STOUR.

This iſland is of a very irregular ſhape, about a mile long, and one half broad, lying in the mouth St Magnus bay, at a little diſtance from the ſhore of the Mainland. It is low, but one of the moſt fertile of the Shetland iſlands, and has ſeveral tolerable harbours, of which Hamna-voe, is the beſt; but the entry is difficult on account of a large ridge of rocks, which runs acroſs the entrance. At Houſe-voe, which is the uſual landing place in coming from the Mainland, ſandſtone, ſandſtone flag, and breccia form one ſide of the voe, which is low and not rugged. In going round the iſland towards the next harbour, called Olis-voe, the ſandſtone ſoon diſappears, when a foſſil, nearly ſimilar to Wacken preſents itſelf, forming cliffs of conſiderable height without any marks of ſtratification, and it continues with little interruption all round the iſland, until it meets with the ſandſtone ſtrata on the oppoſite ſide. From this it appears that theſe two genera of rock form the greater part of the iſland; ſeveral other foſſils, however, are to be obſerved, either in ſtrata, below the Wacken in veins, or ſporadic. Thus in ſome places it is penetrated with a ſpecies of Grunſtein, which is compoſed of white feltſpar and baſaltic hornblende. A few baſaltic veins, or whyn dykes, as the Scottiſh miners call them, are to be obſerved croſſing this rock, and decompoſing ſo as to form a cellular ſtone, which the volcaniſts would have claſſed amongſt the lavas. A ſingular ſpecies of breccia, not unlike that which conſtitutes part of the Calton Hill near Edinburgh, is to be obſerved running below it on the north ſide of the iſland. Veins of ſemi-indurated ſteatites, run through it in various directions, and theſe veins often contain hollow nodules of chalcedony or of red jaſper, which are lined with cryſtals of quartz. Frequently alſo conſiderable veins of red ſinople, intermixed with chalcedony, quartz, and rock cryſtal, run in this rock; and in one place in a fiſſure, filled with calcareous ſpar, I obſerved a few blue cryſtals, that appeared to be fluat of lime.

Having mentioned the principal ſporadic and venigenous foſſils, which are to be obſerved in this Wacken, I ſhall now add a more particular deſcription of it.

WACKEN, from Papa Stour.

Colour.—Brick red, of various ſhades, alſo dark brown.

Luſtre.—None.

Fracture.—Smooth, earthy, but when compact has a tendency to the fine ſplintery.

Hardneſs.—It ſcarcely gives fire with ſteel.

Tranſparency.—None.

Fuſibility.—Melted at 120° of Wedgewood.

It frequently contains feltſpar, forming a ſpecies of Porphyry; ſometimes it is intermixed with the *Grunerde.* It often alſo contains cavities, which are encruſted with dark brown chalcedony, and covered with cryſtallized quartz; and nodules of Onyx, and Sardonyx are ſometimes found in it, I cannot diſmiſs this ſhort account without mentioning, that various ſpecies of pumice are to be gathered in ſeveral of the voes of this iſland, and ſome of the pieces of very conſiderable ſize. Similar kinds of pumice are got near the Giants Cauſeway, in Ireland, and upon the ſhores of the Weſtern iſlands, which Volcaniſts have reckoned a very ſatisfactory proof of their chimera. An examination of the rocks would ſoon ſatisfy any one but a volcaniſt that theſe were adventitious matters. Accordingly their origin is now plainly traced from the famous iſland of Iceland; and this is rendered the more probable, when we conſider the many light ſubſtances floated from the Weſt India iſlands, upon the ſhores of the Shetland and the Weſtern iſlands.

VEMENTRY.

This iſland is ſituated in St Magnus bay, at a conſiderable diſtance from Papa Stour. It is much interſected by the ſea, and riſes higheſt in the middle, forming what is called the Wart of Vementry, upon the top of which there are the remains of a burgh. From this hill we have a view of the whole iſland, and the adjacent coaſt of the Mainland, than which there can ſcarcely be a more dreary proſpect.

From the ſhort time I was upon this iſland, I can only ſay in general, that it appeared to be compoſed of granite, different kinds of micaceous ſhiſtus, and a beautiful ſpecies of hornſtone porphyry, which I obſerved in various ſtages of decompoſition; in ſome ſpecimens the feltſpar appeared to be decompoſed firſt, in others the hornſtone.

MUCKLE RHOOE.

This iſland is about twenty-four miles in circumference, the eaſt and ſouth ſides are low, owing to their being defended from the violent action of the ſea by the Mainland, but the weſt ſide is very rugged and broken. From the little opportunity I had of examining it, I can only ſay that a conſiderable part appeared to be compoſed of granite. Another iſland in the ſame bay, called Papa Little, appears to be compoſed of granite and micaceous ſhiſtus, of various kinds.

CHAP.

CHAPTER IV.

THE NORTH ISLES OF SHETLAND, COMPREHENDING UNST, FETLAR YELL, AND WHALSEY.

UNST.

THIS is the moſt northern of the Shetland iſlands; it is about eight miles long, and from two to two and a half miles broad. Its form is that of a lengthened ſquare; the ſea coaſt is as uſual very rugged, and the iſland is hilly; the higheſt hill which is named Valley-field, is about ſeven hundred feet. There are two excellent harbours, Balta and Uyea Sound, which are often of the greateſt ſervice in ſheltering veſſels that paſs to and from the Greenland ſeas; but the firſt is generally preferred as being more convenient and ſafe. Balta Sound is a pretty deep inlet, formed into an excellent harbour by the iſland of Balta that lies acroſs its entrance, thus forming two paſſages; one from the North is rocky and only fit for ſmall veſſels, but the other from the South will allow large ſhips to enter.

The hills upon the north ſide of this ſound are of conſiderable height, but preſent a very bleak and barren aſpect, owing to the decompoſition of the ſerpentine, of which they are compoſed. This foſſil by the action of the weather acquires an iron brown cruſt, and is often ſomewhat cancellated, ſo as to have much the appearance of a volcanic production.* The ſerpentine is of a green colour, is frequently traverſed with ſmall veins of iron ore, and often aſſumes a fibrous appearance, forming what Wallerius calls talcite; a ſtone very different however from the talcite of Mr Kirwan. It alſo contains ſeveral curious ſporadic foſſils, of which the moſt remarkable are the following:

LAMILLAR ACTYNOLITE, Kirwan. Aſbeſtartiger, Strahlſtein of Werner. This correſponds with the ſpecimen I examined in the Leſkean Cabinet at Dublin, from which Mr Kirwan's deſcription is taken. It appears to be an intermediate foſſil between Actynolite or Strahlſtein and Hornblende.

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* Ponces, 276.

2. LABRADOR HORNBLENDE. This beautiful ſpecies was firſt obſerved upon the coaſt of Labrador, and afterwards in Germany, and ſince in Cornwall by Mr Hatchet.

3. Common or Striated TREMOLITE, Aſbeſtinite of Kirwan.

Colour—Light green.

Luſtre—Silky.

Tranſparency—A little at the edges.

Fracture—Broad ſtriated, the ſtriæ frequently diverging as from a centre. Its fracture alſo preſents what may be called diſtinct concretions, and it is from theſe that the ſtriæ appear often to diverge.

Hardneſs—That which yields eaſily to the knife. By decompoſition it acquires an iron brown cruſt.

Mr Kirwan found that this ſpecies melted into a green glaſs at 150° of Wedgewood; and Klaproth has lately found that in a coal crucible it gives a greyiſh white opaque ſlag, with a loſs of 0,05; and in a clay crucible a compact greeniſh white ſlag is formed, and he has found it to afford

Silex,	0, 65.
Lime,	0, 18.
Magneſia,	0, 103.
Carbonic acid and water,	0, 065.
Oxyd of iron,	0, 005.

The phoſphoreſcence of the tremolites is very remarkable, and it has been found that the degree of effect is inverſely as their hardneſs; thus the ſilky ſoft ſpecies gives a more vivid and red light, with a leſs degree of friction, than the harder kind; the phoſphoreſcence can even be produced by means of a feather.

4. Shistose Talc. Kirwan. Schiefriges Talc. Leſke.

This foſſil is to be obſerved in ſeveral parts of the iſland, running in the Serpentine in the form of veins of conſiderable extent. When long expoſed to the action of the weather it loſſes its ſolidity, becomes friable and ſcaly, acquires a browniſh colour and becomes opaque.

This Serpentine continues to form the hills and cliffs, until we arrive at the beautiful bay of Norwick, when a ſingular ſtriated micaceous ſhiſtus takes its place, forming one ſide of the bay; this alſo conſtitutes a great part of the coaſt until a ſpecies of gneiſs (remarkable for the large ſize of its cryſtals of feltſpar,) makes its appearance, the micaceous ſhiſtus which covered it being waſhed away. Near to this place an immenſe maſs has been ſeparated from the land, forming a great hollow called Saxes Kettle, from the ſea ruſhing through a narrow aperture at the bottom, which cauſes it to boil up with great violence.*

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* Here a Shetland Giant uſed to boil his prey, and terrify the affrighted natives; but more ſurpriſing than this is a famous well at

The land from this runs out to form what is called the point of Lambaneſs, equally ſteep, but not ſo high as the ſides of the bay, and from this to the Sha, the moſt northern point of the iſland, and of his Majeſty's dominions, the gneiſs continues, and does not diſappear until we approach to the deep bay of Bura-firth, where the land becomes higher, forming lofty cliffs of micaceous ſhiſtus. At the bottom of this bay the land is low, preſenting beautiful rocks of undulated micaceous ſhiſtus[†]; but after croſſing the bay we find the land riſe gradually, forming the lofty cliffs of Hermoneſs, which are compoſed of ſimilar rocks. At the bottom of theſe cliffs there are immenſe caves excavated by the ſea, into which a boat can row many hundred feet in calm weather; the entrance is ſaid to be ornamented with regular octogonal pillars, but what their nature is I could not

determine,

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at a little diſtance, where the inhabitants ſay their anceſtors uſed to get boiled or roaſted fiſh, in proportion to the depth they went. This is a fact truly Plutonic, well deſerving the attention of world makers.

[†] This ſpecies is entirely compoſed of mica without any admixture of quartz, which Karſten in his catalogue of the Leſkean cabinet reckons a rare production.

determine, as the ſurf prevented me from approaching. Is it probable that they are formed of gneiſs? for there is no other foſſil near but micaceous ſhiſtus. From this the whole weſt coaſt is very lofty and rugged, compoſed of micaceous ſhiſtus, and this laſt often contains extremely beautiful regularly cryſtallized garnets of great ſize. As we approach the ſouth weſt extremity, the land becomes lower, and towards Belmont, the ſeat of Thomas Mouat, Eſq, of Garth, ſtrata of Ardeſia‡, or primitive Argillaceous Shiſtus are to be obſerved in the neighbourhood of the micaceous ſhiſtus. The Serpentine now again makes its appearance and forms in ſeveral places conſiderable hills, which have as uſual a barren and bleak aſpect. On the ſea ſhore, between Uyea ſound and the caſtle of Mounis, there are ſtrata of ſandſtone; and from this to Balta ſound the hills and ſhores are low, formed of micaceous ſhiſtus with a compound rock of green hornblende and quartz, and in ſome places we obſerve rocks of a compact feltſpar with hornblende.

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‡ It is much to be regretted, that authors will not conſent to uſe a fixed generical name to expreſs the primitive Argillaceous Shiſtus, in oppoſition to the ſecondary ſhiſtus. The term Ardeſia, propoſed long ago by the great Linnæus, will anſwer very well; but it appears to be little attended to.

FETLAR.

This iſland is about four miles long, and three and a half broad, of an irregular ſhape, owing to its being much expoſed to the action of the ſea. Its mineral productions are not very different from thoſe in Unſt; indeed it is probable that at one time they were joined. There are no harbours of any conſequence; the bay of Treſta is one of the largeſt, but is not ſafe in ſtormy weather. One ſide of this bay is compoſed of micaceous ſhiſtus, quartz, with ſtrata of alpine or primary limeſtone. On the oppoſite ſide of the bay there are appearances of plumbago; in one place particularly there is a vein of a matter reſembling an impure plumbago, which is between two and three feet wide, running to all appearance in micaceous ſhiſtus. This latter foſſil forms the coaſt for a conſiderable way. It however diſappears, when immenſe cliffs of ſerpentine are to be obſerved, which often afford beautiful maſſes of rock cryſtal, alſo fine ſpecimens of aſbeſtus and amianthus. The ſerpentine, having formed a conſiderable extent of cliffs, diſappears, when a curious ſpecies of micaceous ſhiſtus preſents itſelf, which is formed of rounded maſſes of quartz of conſiderable ſize, connected by means of mica, thus forming what has been called a primitive breccia. Sauſſure, in the 20th chapter of his Voyage dans les Alpes, deſcribes a nearly ſimilar rock, which he obſerved in the neighbourhood of Valorſine, differing from this, however, in having what he calls a ſhiſto-micaceous baſe, and containing beſides quartz, ſhiſtoſe granite, and micaceous ſhiſtus. This curious rock forms a conſiderable extent of cliffs, but at Strandburgh a micaceous ſhiſtus takes its place, which reſembles hornblende ſlate in its general appearance, but its ſoftneſs affords a ſufficiently accurate diſtinction. This micaceous ſhiſtus alſo forms a conſiderable extent of coaſt, which is low, preſenting a moſt ſplendid appearance when the ſun ſhines, his rays being reflected from the micaceous rock as from immenſe mirrors. As the coaſt riſes the Serpentine again makes its appearance, having the uſual brown, iron-like aſpect, and forming lofty cliffs upon the ſhore; but theſe continue only for a ſhort way, when the micaceous ſhiſtus is again to be obſerved, and continues forming low cliffs to the Houſe of Urie. From this round to the bay of Treſta the coaſt is lofty and precipitous, formed of micaceous ſhiſtus; but at one place there are immenſe cliffs of gneiſs, which by decompoſition form a matter ſimilar to that obſerved at Weeſdale Voe, which is here alſo uſed as fullers earth.

YELL.

This iſland is about four miles from the Mainland, is about ſixteen long, and eight broad, and is next to the Mainland the largeſt in Shetland. There are ſeveral harbours, but none of them large or commodious. It is in general pretty hilly, very much covered with peat moſſes; this with its tremendous broken coaſts, render the iſland wild and gloomy. The hills, as far as I could determine, are compoſed of granite, micaceous ſhiſtus, and quartz. On the weſt ſide, which is extremely broken and rugged, there are ſeveral curious veins of granite, between five or ſix feet wide, that run in the micaceous ſhiſtus. They are ſometimes much curved, but generally run at an angle of about 70°.

WHALSEY.

This iſland is about ſix miles long, and four broad, and is three miles diſtant from the Main-land. The ſhores are low on both ſides, and, as far as I could obſerve, compoſed of granite and micaceous ſhiſtus; the higheſt hill is the Wart, which I found to be compoſed of micaceous ſhiſtus to the top.

At a conſiderable diſtance lies the Grief and Out-Skerries, dreary and deſolate rocks, inhabited by a few fiſhermen, and compoſed of the ſame materials as Whalſey.

ARRAN.

CHAP. I.

SIZE AND SITUATION OF THE ISLAND, CLIFFS, MOUNTAINS, SURFACE, &c. BRODICK BAY AND ITS ENVIRONS COMPREHENDING CORY-GILLS, GLEN-CLOY, GLEN-SHIRREG, GLEN SHANT, GOAT-FIELD AND GLEN-ROSA.

THIS iſland is about thirty-two miles long and twelve broad, ſituated in the mouth of the Frith of Clyde, about eight miles from Bute, and ſixteen from Saltcoats in Ayrſhire. Its ſhape is irregular, but not ſo much ſo as many of the Weſtern Iſlands, which are more expoſed to the Atlantic Ocean; here the vicinity of the Scottiſh and Iriſh ſhores prevents any great deſtruction of land, as is evident from the lowneſs of the cliffs round the iſland, which have not the precipitous, rugged, and bold aſpect of the Shetland Iſlands.

Cliffs. The cliffs are ſeldom above two hundred feet high, are generally precipitous, having frequently, however, an intervening bank between the cliff and the ſea, formed by the deſtruction of the rocks, which are either of ſandſtone or micaceous ſhiſtus. Conſiderable ſandy beaches frequently occur, formed of the debris of granite, ſandſtone, and micaceous ſhiſtus, and ſometimes we remark a conſiderable extent of coaſt, covered with enormous maſſes which have been torn away by torrents, or ſeparated from the neighbouring rocks by the vaſt expanſive power of froſt.

Mountains. No regular ridge of mountains is to be obſerved; theſe being either in the form of groups, as Goatfield and the adjacent mountains, which preſent aſtoniſhingly grand peaked ſummits; or irregular, forming round-backed hills, as thoſe towards the ſouth part of the iſland.

Surface. The land is in general very high, particularly towards the north-end, where the wonderful group compoſed of Goatfield, Cairn-na-callich, &c. preſent mountains near three thouſand feet high. Here nature exhibits to the aſtoniſhed eye the moſt terrific and ſublime ſcenery; to convey even a faint idea of which would require an able pen. The ſouthern parts are lower, and in place of the bare rocky appearance of the North, we have heath-covered hills, and a conſiderable portion of cultivated land.

The iſland is divided into two pariſhes, Kilbride and Kilmory, belonging to three proprietors; the Duke of Hamilton, Marquis of Bute, and John Fullerton, Eſq. of Kilmichael; and yields about 5000l. of yearly rent. This indeed might be much encreaſed were proper methods of cultivation followed; and were long leaſes and larger farms properly granted, more happineſs, induſtry and wealth would be the natural conſequence.

In deſcribing the iſland particularly, I ſhall begin with *Brodick Bay*, which is ſituated on the eaſt ſide. This beautiful bay is bounded, on the ſouth, by the hills of Cory-gills; on the weſt, by the vales Glencloy, Glen-ſherrig, Glen-ſhant; and on the ſouth, the tremendous Goat-field forms a lofty boundary. It is of an irregular ſhape, about five miles long, and four deep, having about five fathoms water, with good anchorage ground; but it is only in moderate weather that veſſels can ride in ſafety. From this bay paſſage boats go to Saltcoats, about ſixteen or eighteen miles diſtant, which renders this the principal thorough-fare in the iſland; ſo that the population is conſiderable. Many viſitors come from the mainland, during the ſummer months, to enjoy the free air, and admire the wonderful ſcenery of this intereſting iſland;—but the want of a good inn is much to be regretted. On the north ſide of the bay ſtands Brodick Caſtle, an old ruinous building, inhabited occaſionally during part of the ſummer by the Duke of Hamilton. It is ſituated upon the ſide of Goat-field, commanding a moſt extenſive and delightful proſpect, and might eaſily be made one of the moſt beautiful ſeats in Scotland. About two miles diſtant, in Glencloy, is ſituated the pleaſant ſeat of the ancient family of Fullerton, of Kilmichael; where the trueſt hoſpitality, joined to the moſt attractive manners, leave the ſtranger only to regret his departure from ſo much happineſs.

Mineralogy.—The mineral hiſtory of this part of the iſland is, in many reſpects, intereſting; not only on account of the variety of foſſils which it affords, but also in preſenting to us, in a ſhort ſpace, a repreſentation of the ſtructure and materials of nearly the whole iſland. On this account I ſhall be minute in my deſcription, as I may have occaſion to refer to this particular part, when deſcribing ſome of the other quarters of the iſland.

The ſouth ſide of the bay is low immediately upon the ſhore, it however riſes gradually; forming the hills in the neighbourhood of Cory-gills, and towards the ſea, cliffs of conſiderable height, almoſt entirely compoſed of ſandſtone *. This ſandſtone is pretty compact, of a reddiſh colour, much reſembling that found in Shetland, and is here and there

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* A curious obſervation with regard to ſandſtone, has been lately made in Germany. In the ſandſtone quarries, if the looſe ſtony and ſandy matter be left undiſturbed for ſome time, the ſtones are found covered with a tranſparent ſiliceous cruſt, and the particles of ſandſtone are cemented by a ſimilar ſiliceous matter. There, then, we have a moſt deciſive proof of the ſolubility of the ſiliceous earth in water. Dr Hutton and his followers, deny the ſolubility of this earth in water, and carry the point ſo far as to diſbelieve

there alternated with ſtrata of breccia, compoſed of rounded fragments of quartz, with fragments of ſandſtone, of various ſizes and ſhapes; and both theſe ſtrata run at an angle of from 10 to 15°. In many places there are very conſiderable veins of baſalt, or what have been called whyn dykes, * croſſing the ſandſtone in various directions. Some may be obſerved riſing from the ſea, and penetrating the ſandſtone. In other places, where the ſuperincumbent ſandſtone has been completely carried away, veins, can be remarked running with little variation, in diameter or direction, for nearly a

mile

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believe the petrifying power of Loch Neagh, in Ireland. A fact lately obſerved in Germany ſhows completely the futility of ſuch an opinion: a wooden bridge, built upon the Rhine in the time of Julius Cæſar, was lately demoliſhed, when the lower part of the ſtakes were obſerved to be *ſilicified*.

* This term, like many other popular denominations, does not convey a diſtinct idea of any particular genus of foſſils, but is uſed by the inhabitants of Scotland, and the north of England, to expreſs thoſe foſſils which are of *Baſaltic formation*. Mineralogiſts in many inſtances appear to have uſed it in a very vague manner; thus ſome deſcribe Trap, others Baſalt; and not unfrequently Grunſtein, and indurated clay have been arranged under this name. It is much to be wiſhed that it could be entirly laid aſide, particularly when we perceive that the great Werner has framed ſatisfactory characters for theſe different rocks.

mile. Theſe veins are not only to be obſerved upon the ſea ſhore, but can be traced running in various directions, and of different diameters, thro' the ſandſtone and other rocks, in the interior of the iſland, as we ſhall afterwards clearly demonſtrate. In aſcending the hill towards the Cory-gills, a very conſiderable vein of dark green pitchſtone makes its appearance, running from the cliffs upon the ſhore, through the ſandſtone, to the Lamlaſh road, where we ſoon loſe it amongſt the ſandſtone in the neighbouring hills. This vein is of various breadths; in ſome places, as at the Lamlaſh road, being about eight feet. It does not appear to have altered the ſandſtone, where it is in contact with it; but in ſome parts of the vein, the pitchſtone, as it approaches the ſandſtone, loſes much of its luſtre, and, in fracture and hardneſs, approaches to the nature of baſalt. Higher up above the houſes of Cory-gills, we obſerve a number of columns, which are compoſed of wacken-porphyry. Theſe pillars are in various directions; ſome are perpendicular to the horizon; others more or leſs inclined; and, what is ſingular, we find, further up, that they are quite horizontal. They are in the form of four or ſix-ſided columns, from ſix to ten feet long, and two or three feet in diameter, having a whitiſh cruſt from decompoſition. They are not jointed, nor is there any appearance of balls, or what the volcaniſts call *volcanic bombs!* I endeavoured to diſcover the relative poſition of the ſandſtone and porphyry, but could not detect them in contact with each other, nor could I draw any probable concluſion as to their relative poſition. In deſcending from this porphyry hill towards Lamlaſh, the ſandſtone again makes its appearance, but is ſoon loſt, being covered with grunſtein, which forms the ſummits of ſeveral hills in the neighbourhood, and may be remarked running towards the ſea, forming cliffs. In one place we obſerve a great body of green-coloured pitchſtone, which runs quite in an oppoſite direction to the vein we obſerved croſſing the Lamlaſh road; in ſhort, it appears to be ſtratified, and to run immediately below the grunſtein. About twenty yards lower, another maſs occurs about ten or twelve feet thick, and which, as far as I could determine, appears to form a ſtratum running between the ſandſtone and grunſtein.

Having now mentioned the poſition of the veins and ſtrata, upon the ſouth ſide; we ſhall return to the ſea ſhore, where we obſerve the bay riſing towards the weſt, forming the one ſide of Glen-Cloy.

GLEN-CLOY. This glen is nearly three miles long, and half a mile broad; open towards the eaſt, but bounded on the other ſides by high hills. At the top, or weſt part of the glen, the hills are higheſt, forming a very romantic groupe of rocks. The north and ſouth ſides, which are of conſiderable height, become gradually lower as they approach the ſea, where they form part of Brodick bay. The bottom of the glen riſes gently from the ſea, forming a ſmall angle with the hills that bound it. Immediately under the peat-moſs or heather we diſcover bowlder ſtones, which form horizontal beds, from three to thirty feet thick, and in other places they are collected together in heaps, being thrown into this form by the force of water. Theſe bowlder ſtones are not of very conſiderable ſize, and vary but little in that reſpect at the top or bottom of the glen; which ſhews that the greater part of them have not received their rounded form by attrition in the water of the glen, but are derived from a decompoſed breccia. They conſiſt of granite, porphyry, ſcenite, breccia and ſandſtone, which are all to be obſerved in the neighbouring hills. Through the glen runs Glen-Cloy burn, formed by the ſprings and rains from the hills; it is narrow, but, during violent ſtorms, it overflows a conſiderable part of the glen, and has thus laid bare the rocks, and ſhows us in a ſatisfactory manner the nature of the ſubjacent ſtrata. The bottom of the glen is compoſed of the common red coloured argillaceous ſandſtone, and here and there are ſtrata of breccia, and both are traverſed with veins of baſalt, which run in very various directions, and are from three to twelve feet in breadth. Theſe veins, in their paſſage through the ſtrata, (to uſe the Huttonian language) do not appear to have occaſioned in them any alteration with regard to hardneſs; on the contrary, we often find a ſpecies of ſemi-indurated clay interpoſed between the ſandſtone and baſalt. The hills on the north and ſouth ſides of the glen are of the ſame height, and the pente of the hills appears to correſpond pretty nearly with the elevation of the ſtrata.

The hills on the ſouth ſide are formed of ſandſtone and breccia, which, towards the upper end, form very lofty precipices; many veins of baſalt traverſe the ſandſtone, and looſe nodules of a ſingular ſpecies of black pitchſtone lie ſcattered here and there. On the north ſide, near to Brodick wood, a very conſiderable vein of green coloured pitchſtone (much reſembling that at the Lamlaſh road) makes its appearance running through the ſandſtone. In aſcending the hills upon this ſide, after gaining a conſiderable height, the ſandſtone diſappears, when a wacken-porphyry is to be obſerved, and, upon the brow of the hill, where the rains, &c. have made a ſection of the ſtrata, we obſerve ſeveral curious phenomena. In the firſt place, we remark the great tendency which the porphyry has to aſſume the columnar form; in ſome places they are pretty diſtinct, as at B;* but in others they are not to be obſerved as at A. The next appearance which claims our notice is the remarkable poſition of the baſaltic veins, which run in various directions through the ſandſtone and porphyry. One great vein, C, is very ſtriking. It is ſeen riſing from the

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* See Plate.

neighbourhood of the ſandſtone ſtrata penetrating the wacken-porphyry, and as it riſes upwards getting a conſiderable curve; when it branches, one branch riſes to the top of the hill, the other runs but for a ſhort way into the porphyry in the form of a wedge. Near to the ſame place another vein of baſalt, D, is to be obſerved, running in an almoſt oppoſite direction, terminating in a wedge form; but, what is ſingular, we find intercepted between the porphyry and the vein, on its upper ſide, a ſandſtone breccia, and on the lower a hard ſiliceous ſandſtone. The weſt or upper end of the glen is formed of ſandſtone, pretty much traverſed with veins of baſalt, which are more or leſs inclined and of various diameters. Beſides this ſandſtone we obſerve lofty precipices of ſcenite, which form ſtrata elevated at an angle of about 30°. This rock is not only very much varied in the nature of its conſtituent parts, but alſo in the degree of the intimacy of combination, which renders it very difficult to determine its different ſpecies. It is alſo penetrated with veins of baſalt, but not ſo much ſo as the ſandſtone.* It forms the higher part of ſeveral of the hills betwixt the top of this glen and the Shiſkin, and is all along penetrated with baſaltic veins.

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* Dr Hutton, in his ſpeculations upon the Theory of the Earth, remarks, "If it be by means of heat and fuſion that ſtrata have been

It appears, from the deſcription which has been now given, that the ſandſtone forms by far the greateſt part of the glen; the next in proportion is the porphyry, and laſtly the ſcenite.

No ſubject is more intereſting or uſeful, than an examination of the relative poſition of ſtrata and veins; in ſhort, upon this is founded all our knowledge of geology. It is, however, attended

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" been conſolidated, then, in proportion to the degree of conſoli-
" dation they have undergone from their original ſtate, they ſhould
" *cæteris paribus*, abound with more ſeparations in the maſs. But
" the concluſion is found conſiſtent with appearances. A ſtratum
" of ſandſtone does not abound ſo much with cutters and veins as
" a ſimilar ſtratum of marble, or even a ſimilar ſtratum of ſand-
" ſtone that is more conſolidated, they are in general interſected
" with veins and cutters; and in proportion as ſtrata are deep in
" their perpendicular ſection, the veins are wide, and placed at
" greater diſtances." This does not appear to be conſiſtent with fact, for it is to be obſerved in Arran that the ſandſtone contains more veins than the ſcenite, which laſt is greatly harder than any ſandſtone in the iſland, and we obſerve that the ſcenite contains a greater number of veins than the granite, although it be ſofter and leſs compact.

tended with great labour and difficulty, not only on account of the many turnings and ſuperpoſition of ſtrata, &c. but alſo from the frequent impoſſibility of tracing theſe ſtrata in ſuch a manner as to convince us of their relative poſition. This laſt circumſtance prevented me from determining, with ſufficient accuracy, whether the porphyry lay upon the ſandſtone, or the ſandſtone on the porphyry; one fact inclined me to ſuſpect, that they were both formed at the ſame time, and that the porphyry lies upon the ſandſtone. It was the remarkable vein of baſalt, C, riſing from the bottom of the glen, through the porphyry, which led me to preſume that the ſandſtone and porphyry were formed at the ſame time; the vein appearing to riſe through the ſandſtone and to penetrate the porphyry in the ſame direction. We have more certainty with regard to the ſcenite, which appears to be of an origin anterior to the ſandſtone, as is pretty well ſhewn from the appearance of a breccia that lies upon its ſurface, which had been interpoſed between it and the ſandſtone, before the cauſes which formed the glen had carried away the ſandſtone.

Glen Shirreg. This glen is of conſiderable extent, bounded upon the one hand by Glen-Cloy, and on the other by Glen-Shant. The hills towards the weſt are not ſo rugged as thoſe at the top of Glen-Cloy; and both the bottom and ſides are formed of the common ſandſtone, much penetrated with veins of baſalt, but towards the ſouth-weſt we obſerve the wacken-porphyry, which forms part of the rocks higher up than the ſandſtone, and is in fact, part of the maſs we obſerved before in Glen-Cloy.

Glen-Shant. This forms the entrance into the tremendous Glen-Roſa, has Glen-Sherrig upon one ſide, and Goatfield on the other. On the ſouth ſide, ſandſtone, traverſed with veins of baſalt, makes its appearance, but as we proceed up the glen it is loſt, and micaceous ſhiſtus takes its place. On the other ſide a very little ſandſtone is to be obſerved at the bottom of the hills, and the whole of the upper part is compoſed of micaceous ſhiſtus of various ſpecies.

Goatfield. This mountain, according to Profeſſor Playfair, is about 2945 feet above the level of the ſea, and is reckoned the higheſt in the iſland. It riſes pretty rapidly from the ſouth ſide of Brodick bay, until we arrive at the region, where the micaceous ſhiſtus diſappears. There is a kind of irregular plain, from which the mountain riſes in the form of an obtuſe pyramid, and is very precipitous, being entirely formed of granite. On the weſt, where it forms part of Glen-Roſa, it is extremely ſteep, which is owing in a great meaſure, to the want of micaceous ſhiſtus and ſandſtone; for wherever theſe occur, the declivity is leſs ſudden. On the eaſt ſide the pente is more gradual, marking according to the ſteepneſs, the preſence of granite, micaceous ſhiſtus, or ſandſtone. It declines a little towards the north, but riſes again, forming one of the boundaries of the rude Glen-Sanicks; it alſo forms the top of the bare, rugged, and ſterile Cory-Glen, and the top of other two great hollows between the Cory-Glen, and Glen-Sanicks.

The lower part of Goatfield is compoſed of the uſual red-coloured ſandſtone, and is traverſed by veins of baſalt; this continues for ſeveral hundred feet up the mountain, when it at laſt diſappears, the micaceous ſhiſtus riſes from under it, ſeparated only by a ſtratum of breccia, thus ſhewing the junction of the ſandſtone and micaceous ſhiſtus. The micaceous ſhiſtus continues until we arrive at the plain formerly mentioned; but the ſide of the mountain is ſo covered with the debris of granite, micaceous ſhiſtus, &c. that it is only by the appearance of the granite in the neighbourhood of this plain, that we are aware of its exiſtence, as the aſcent is hardly more ſteep over the micaceous ſhiſtus than the ſandſtone, which is not generally the caſe; for we find, when the ſtrata are not covered with debris, that the ſandſtone is far leſs ſteep than the micaceous ſhiſtus, and this laſt than granite. Even in this way, we have a kind of general rule, for judging of the nature of mountainous ridges: if they be peaked and very precipitous, we may preſume that they are of granite; if they be leſs lofty and not peaked, but ſtill ſomewhat approaching to the conical ſhape, we may ſuppoſe them to be compoſed of micaceous ſhiſtus; and laſtly, if we obſerve theſe ſkirted by lower mountains, with a trifling pente, we may conclude that they are compoſed of ſandſtone and limeſtone.

The pyramidal part of the mountain has a very ſteril and wild aſpect, being completely covered with looſe blocks of granite, and deſtitute of all vegetation, excepting a few lichens, which only add to its rude appearance. Theſe blocks differ very much in ſize, ſome being about twenty feet long, and generally of a quadrangular ſhape, and are ſo heaped upon each other, as to render the aſcent very difficult. Having, however, gained the ſummit, we are well repaid for our labour, by a moſt extenſive view of a wonderful diverſity of country. To the northward we look down upon the peaked ſummits, and deep glens in the neighbourhood of Goatfield, whoſe arid and reddiſh appearance, ſuggeſt freſh to our minds the effects of a dreadful conflagration. Beyond theſe, the iſthmus of Cantyre, the iſland of Iſla, the lofty and dreary paps of Jura, the long mountainous ridges of

Argyleſhire, and the far diſtant mountains of Mull, which are faintly deſcried, preſent a view, rather to be felt than deſcribed. On the eaſt, the well cultivated iſland of Bute, the firth of Clyde, the Cumbray iſlands backed with the beautiful coaſts of Renfrewſhire, form a moſt picturesque ſcene. Towards the ſouth we have below us the lower part of the iſland ſpread out like a map, forming a ſingular appearance, of heath covered mountains, and cultivated glens; further diſtant, the charming coaſts of Ayrſhire, the ſhores and mountains of Galloway, as far as the Mull, the ſtupendous craig of Ailſa, riſing from the boſom of the ocean; all delight the eye, and raviſh the imagination. Laſtly, on the weſt, the coaſt of Ireland, from Fairhead, to Belfaſt Loch, conclude the amazing view from this intereſting height.

GLEN-ROSA. This very ſtriking glen, ſituated upon the weſt and ſouth-weſt ſides of Goatfield, is about five miles long, and half a mile broad, bounded by very high mountains. The bottom forms a conſiderable angle with the ſides, riſing gradually towards the upper, or north end, where it is formed partly by the mountain called Keid-vere, and partly by Goatfield. From this we view, on one hand, the glen in all its extent, on the other we look into the dreadful hollow of Cory-na-huave, and the long extended Glen-Sanicks, which runs from this, and forms an aſtoniſhing ſcene. The mountains on the oppoſite ſides of the glen, are of different heights, (being far higher on the eaſt than weſt) but the inclination of the oppoſite ſlopes is the ſame, being about 70°. The bottom and ſides of the glen are formed of granite, ſimilar to that of Goatfield, forming what I conceive to be immenſe, nearly vertical ſtrata, which run nearly in the direction of the glen, which is north and ſouth. Theſe ſtrata (if they may be ſo called) preſent from the bottom of the glen their flat ſurfaces, which are ſplit in many places, into rhomboidal maſſes, ſo that we cannot perceive the marks of ſtratification until we mount up many hundred feet, when the edges of the ſtrata are diſtinctly perceived running for a great extent, emerging here and there from below the looſe blocks of granite, which have fallen from the top of the mountain,

tain, or have been formed by the ſplitting from the ſurface of the ſtrata themſelves.

La Metherie in the laſt edition of his Theorie de la Terre, ſpeaking of the primitive mountains remarks : [*]" Les maſſes ne ſont ni par bancs, ni " par couches, comme l'ont pretendu des ſa" vans naturaliſtes. J'ai parcouru une grand " quantité de terreins primitifs, et je n'y ai ja" mais vu de couches. Quelquefois on apper" coit des maſſes aſſez conſiderable de granits, " ayant une figure preſque rhomboidal, ſuper" posés les uns ſur les autres. Mais on ne ſau" roit regarder ces ſuperpoſitions pour de " couches, puiſqu'elles n'ont rien de regulier, " et que ces maſſes, preſque rhomboidales, ne " ſe rencontrent que tres rarement. Le plus ſou" vent ces granites ſont fendilles, en different " ſens. Ces ſciſſures ſe correſpondent quel" quefois ; ce qu'on prendroit au premier coup" d'œil pour des eſpeces des couches. Mais un " examen plus approfondi en fait bientot recon" noitre la difference."

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[*] Theorie de la Terre, Tom. 4, p. 352.

From theſe obſervations, La Metherie does not appear to have obſerved the phenomena ſo well deſcribed by Sauſſure, and which, as I preſume, occur in Arran. What he deſcribes are appearances which occur in almoſt all granite countries. The ſuperpoſition of blocks of granite upon each other, could hardly be miſtaken for ſtratification; the ſplitting of granite, however, is often apt to deceive, if the concomitant circumſtances be not examined with ſufficient attention*.

Upon the eaſt ſide of the glen, ſeveral curious appearances are to be obſerved; of theſe the moſt intereſting are the baſaltic veins, which traverſe the granitical ſtrata, as they do the porphyry and ſandſtone. The firſt vein which I diſcovered, being between three and four feet in diameter, is to be obſerved riſing through the granite, ſeveral hundred feet above the bottom of the glen; its lower part is hid by the heather, and looſe blocks of granite, which cover the ſides of the mountains.

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* Dr Walker informs me that the granite in Galloway, is ſtratified, with ſuch diſtinctneſs, that it is raiſed by the quarriers in immenſe flat maſſes.

As it riſes upwards it becomes gradually narrower, and at laſt divides into two branches, which run through the granite, contracting and enlarging their diameter from a few inches to more than two feet. The extremity of one of theſe branches, appears either to have been broken, or ſo bent downwards as to cauſe one part of the branch to have the appearance of being ſeparated from the other as is repreſented in the plate, where A is the granite, B the baſalt vein, C the branch having the appearance of being ſeparated from D by intervening granite. In the body of the great vein there is immerſed a conſiderable wedge-ſhaped piece of granite, marked in the plate at E, which has the uſual hardneſs, colour, &c. of that ſpecies of which Goatfield is formed. In ſome parts the vein is bounded by ſmall grained compact granite, in others by the common granite of Goatfield. The granite and baſalt are not intermixed at their junction, no matter is interpoſed, and they are not altered in the leaſt by being in contact with each other.* In the neighbourhood of this vein I found ſpecimens of rock cryſtal in cavities of the granite, and ſeveral other foſſils. Amongſt theſe the moſt remarkable was a ſpecies of granite much allied to the Pierre graphie, a foſſil which is found at Portſoy in Banffſhire, and in Siberia. Here I alſo obſerved ſpecimens of the ſhiſtoſe granite adhering to the common kind, and alſo a granite, where the feltſpar, quartz, and mica, were diſtributed in a radiated form, as is the caſe with many zeolites.*

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* Mr Mills, in his account of ſome ſtrata in Ireland and Scotland, detailed in the London Tranſactions for 1790, mentions the appearance

Near to the top of the glen, upon the ſame ſide, many fragments of baſalt are to be obſerved, lying upon the ſides of the mountains, ſhowing the preſence of baſalt veins, and at the Keid-vore a

great

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appearance of a vein of baſalt, or vein of lava as he calls it, about two feet wide, included in a vertical fiſſure of granite, ranging N. E. by E. and N. W. by W. in a ſmall iſland in the ſound of Jona in the Hebrides.

* Dr. Hutton imagines that this ſpecies of granite affords him a proof of the igneous origin of granite in general. It will be viewed otherwiſe, if we obſerve that it does not differ from the common ſpecies, but in the irregularity of the cryſtallization of its conſtituent parts; and it is plain that the feltſpar has impreſſed no figure upon the quartz, as the ſtrata is an appearance characteriſtic of the moſt regularly cryſtallized rock cryſtal.

great vein is to be ſeen riſing perpendicularly through the granite. Nearly at the ſame place, I was much ſurprized to find ſeveral maſſes of green coloured pitchſtone lying amongſt the debris of the granite; but, after conſiderable labour, I was not able to detect its ſituation.

Not far diſtant from this, in aſcending towards the ſummit of Goatfield, I obſerved, amongſt the looſe blocks of granite which cover its ſides, a curious appearance. Upon breaking theſe rocks with an expectation of diſcovering rock cryſtal, I found in ſeveral of them maſſes of compact granite, of different ſizes, either rounded or angular. Sauſſure mentions a ſpecimen, in the poſſeſſion of Werner, of a granit-en-maſſe, incloſing diſtinct cailloux roulés; which appears to be of the ſame nature with this.

The weſt ſide of the glen is formed in part by a granitical mountain, named Ben-echleven, which preſents to us the great flat ſides of the granitical ſtrata; its top is covered with enormous blocks of granite, which reſt upon each other in a moſt fantaſtical manner. This mountain declines rapidly towards the north-eaſt, forming a tremendous hollow, named Cory-dain, whoſe bottom is far elevated above that of Glen-Roſa, but is lower than the bottom of the next hollow, named the Feun-hody, which is raiſed far above either, preſenting to the bewildered eye an amazing ſcene of ridged and peaked rocks of granite. In the Cory-dain, the granite at firſt ſight appears to be ſtratified horizontally; but an examination ſhews us that it is owing to the ſplitting of the granite. Here alſo we obſerve the granite diſintegrating in the form of ſand; and what is more rare, decompoſing in the manner of ſome ſpecies of baſalt; that is, in cruſts. Sauſſure, ſpeaking of this kind of decompoſition, remarks, " Un autre fait, dont " je trouvai la ſolution en examinant ces granits " de prés et avec attention, c'eſt celui de ces exfoliations, que j'avois obſervées dans la vallée " ſupérieure. C'eſt un fait connu de tous les mineralogiſtes, que la plupart des pierres ſont plus " tendre dans le ſein des montagnes qu' a leur exterieur, et qu'elles acquierent a l'air un degré " de dureté ſenſible. Il ſuit dela, que la partie " exterieure, ou le bord de la tranche verticale d' " une grand aſſiſe de granit doit ſe durcir par le

“ contact de l’air, tandis que l’interieur de la
“ meme aſſiſe conſerve un certain degré de mol-
“ leſſe. Et tant que les aſſiſes inferieures de-
“ meurent un peu molles, le poid enorme de
“ toutes celles qui repoſent ſur elles, doit a la
“ longue les comprimer. Mais les parties exte-
“ rieures, durcies par le contact de l’air, ne ſont
“ pas ſuſceptible de la meme compreſſion. Elles
“ doivent donc s’en ſeparer, et former ainſi les
“ exfoliations que l’on obſerve.*”

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* Sauſſure, Voyages dans les Alpes, tom. VI. p. 318.

ARRAN.

CHAP. II.

DESCRIPTION OF THE FOSSILS, MENTIONED IN THE PRECEDING CHAPTER.

PITCHSTONE.

ARGILLA PICEA, Werner; Obſidian, Dr Walker's Claſſes foſſilium; Pijſite La Metherie.

PITCHSTONE, from Lamlaſh road.

Colour.—Dirty green, much the ſame with that from Brodick wood.

Luſtre.—Like that of cryſtals, or metals not much poliſhed. Is often beautifully irideſcent, and this is particularly the caſe at the thin edges of the ſplinters.

Hardneſs.—Gives a few feeble ſparks with ſteel, but is very brittle.

Fracture.—More or leſs perfectly multiplied, conchoidal, or ſplintery.

Fragments.—Almoſt always in the form of four ſided irregular columns.

Tranſparency.—Tranſmits a very little light at the edges.

Fuſibility.—At 118° of Wedgewood's pyrometer it had intumeſced a little, like zeolite, forming a porous maſs of a whitiſh colour, intermixed with pink.

This ſpecies is often intermixed with one ſimilar to that obſerved at Brodick wood.

PITCHSTONE, Brodick Wood.

Colour.—Dirty green, but the number of diſtinct concretions give it a light hue.

Luſtre.—Greaſy.

Tranſparency—Tranſmits a very little light at the edges.

Hardneſs.—Gives a few ſparks with ſteel.

Fracture.—Uneven, conchoidal, and ſometimes ſplintery, with numerous diſtinct concretions. In the groſs is often ſlaty.

Fuſibility.—At 75° formed a compact glazed maſs, coloured red and white. At 100° it forms a compact maſs, having, however, in ſome parts the appearance of pumice*.

The different ſpecies of this genus have been found to differ conſiderably in their degree of fuſibility, but in none ſo remarkably as the one now deſcribed. Mr Kirwan, who has made the moſt ſatisfactory experiments upon their fuſibility, obſerved, that the moſt fuſibile formed an enamel at 130°, but in general were far more refractory, ſome refuſing to melt at 160°. Widenman alſo found them to differ conſiderably in this reſpect. It will be difficult, then, to ſay with confidence, that either of the Arran ſtones belongs to this genus, at leaſt, if we are to carry the character of fuſibility ſo far as Mr Kirwan has done in the caſe of the Gemeiner Kieſel Schiefer of Werner.

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* The Abbé Spallanzani, in his travels through the two Sicilies, remarks, That Pumice cannot be formed from any kind of natural glaſſy ſubſtance; the fact mentioned above, renders this ſomewhat doubtful.

It decompoſes by the action of the weather in the form of a white tegmen, which is often ſeparable into layers. It is alſo frequently traverſed with another ſpecies, which has a greater degree of luſtre, and is more difficultly decompoſable by the action of the weather; on account of this laſt cirumſtance, ſpecimens of this kind, when decompoſing, preſent a ſtriped ſurface of dark green and white, the dark green being the undecompoſed ſpecies. Gerhard, in his Mineral Syſtem, mentions a ſpecies of gneiſs and granite, that contains obſidian, a ſtone much allied to pitchſtone. Townſon, in his travels through Hungary, remarks, that this gneiſs is a ſpecies of obſidian, with black and white layers, containing alſo, probably a few cryſtals of adularia, and ſcales of mica. The ſtone I have now deſcribed, appears to be of the ſame kind, and this is rendered more probable from its ſometimes containing feltſpar.

BLACK PITCHSTONE.

South ſide of Glen-Cloy.

Colour.—Black.

Luſtre.—Much like that of ſilk.

Tranſparency.—None.

Hardneſs—Gives a few ſparks with ſteel.

Fracture.—Uneven, with a ſlight tendency to the conchoidal.

Fuſibility.—It begins to melt at 31°; at 65° intumeſces very much, forming an extremely cavernous yellowiſh brown coloured maſs, and at 100° it was leſs cavernous, and had more of a yellowiſh colour.

This foſſil differs remarkably from the pitchſtones, not only in fuſibility, but alſo in external characters; it is therefore a queſtion whether it ſhould not form a diſtinct genus.

BLACK PITCHSTONE.

2d Species.

Colour.—Black.

Luſtre.—Is conſiderably more ſtrong than the firſt ſpecies, approaching to that of metals, or cryſtals not much poliſhed.

Tranſparency.—None.

Hardneſs.—Gives a few ſparks with ſteel.

Fracture.—Uneven with minute rounded concretions.—Pretty often contains cryſtals of white feltſpar.

BLACK PITCHSTONE.

3d Species.

Colour.—Blueiſh black, in other directions common black.

Luſtre.—Like that of cryſtals, or metals not much poliſhed.

Tranſparency.—None.

Hardneſs.—Scarcely gives fire with ſteel.

Fracture.—Uneven, with a tendency to the conchoidal.

Fuſibility.—Formed a black cellular maſs, at 47° and at 52° was more compact.

This ſpecies was found in the low iſland of Egg, one of the Hebrides, by Dr Walker; and is the

only

only place in Scotland, where it has as yet, been obſerved.

Theſe different kinds of Black Pitchſtone appear to paſs imperceptibly into baſalt; a curious ſpecimen of this kind occurred to me, in the neighbourhood of Kilmichael-Houſe, in Glen-Cloy. One part is common black pitchſtone, but it gradually loſes its luſtre, its fracture paſſes from the conchoidal to the plain ſplintery; then it gives a grey ſtreak, is not at all fragile, in ſhort is a fair baſalt. Their great fuſibility leads me to ſuſpect, that they contain an alkali; which is likely pot-aſh, as this kind of alkali has been found in various mineral ſubſtances, as the lepidolite, leucite, or Veſuvian garnet, lava, pumice*, and zeolite. If this ſhould be found to be the caſe, it is not unlikely that it enters into the compoſition of the fuſible ſpecies of baſalt, particularly when we recollect, its gradation to black pitchſtone.

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* Dr Kennedy, of Edinburgh, in an excellent paper, lately read to the Royal Society of that place, has demonſtrated the preſence of pot-aſh, in a conſiderable proportion in ſeveral kinds of pumice.

BASALT.

BASALT, Werner; Common Trap, Kirwan.

Baſalt, ſouth ſide of Glen-Cloy.

Colour. Black.

Luſtre. A number of ſhining particles diſperſed through it, which are probably hornblende.†

Tranſparency. None.

Hardneſs. Scarcely gives fire with ſteel.

Fracture. Even earthy, but is very compact.

By decompoſition acquires a browniſh coloured tegmen.

BASALT, which forms a vein, running in the porphyry, head of Glen-Cloy.

Colour. Lavender blue, intermixed with yellowiſh green; by decompoſition, brick red.

Luſtre. None.

Tranſparency. None.

Hardneſs. Yields pretty eaſily to the knife.

Fracture. Rather uneven fine ſplintery.

Fuſibility. Melted at 103°.

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† Hornblende having been found to contain charcoal, or probably carbone as a conſtituent part, has been ingeniouſly mentioned by Dr Walker, as one fact, to ſhow the tranſition from Plumbago to Hornblende, which he imagines he has obſerved in ſeveral other inſtances.

BASALT, which forms veins traverſing the granite, eaſt ſide of Glen-Roſa.

Colour. Greyiſh or black.

Luſtre. A number of cryſtals of hornblende, diſperſed through it, give it a ſlight degree of luſtre.

Tranſparency. None.

Hardneſs. Gives a few ſparks with ſteel.

Fracture. Uneven earthy.

Gives a grey trace.

Fuſibility. Melted at 58°. This remarkable fuſibility diſtinguiſhes it from the ſpecies of Baſalt examined by Mr Kirwan. He found them fuſible from 120° to 130°, and the figurate trap, or columnar baſalt, melted at 100°.

It contains yellow coloured *Olivin*, but in greater quantity than I have obſerved in other ſpecies. The olivin does not occur in the baſalt which traverſes the ſandſtone ſtrata.

SCENITE.

This rock, we have remarked, forming ſtrata at the head of Glen-Cloy, and it occurs in many other parts of the iſland; we ſhall now mention its external characters. To prevent repetition, I will ſhortly detail the different ſpecies, placing the ingredients in their order of proportion.

1ſt Feltſpar, reddiſh.
Hornblende, green and ſometimes black.
Quartz, white and ſometimes brown.

This ſpecies is more or leſs compact, and is ſometimes ſhiſtoſe.

2d, Hornblende, green.
Quartz.
Feltſpar.

This aggregate, which is almoſt entirely compoſed of hornblende, has the following characters:

Colour—Dark green.

Luſtre—A number of ſhining points diſperſed through the maſs, owing to the hornblende.

Tranſparency—None.

Hardneſs—Gives fire with ſteel, but not very plentifully. Leaves a grey trace. It is difficultly diſtinguiſhable from many ſpecies of baſalt, and is often intermixed with patches of the firſt ſpecies.

3d, Quartz.
Feltſpar.
Hornblende.

This ſpecies, owing to the great proportion of quartz, has much the appearance of a ſandſtone.

4th, Hornblende.

Quartz.
Greeniſh coloured feltſpar.

The hornblende in this compound, has ſometimes a metallic luſtre, approaching to the nature of ſchiller ſpar; and the feltſpar is tinged green, owing to the diffuſed matter of the hornblende.

PORPHYRY.

WACKEN-PORPHYRY from Cory-Gills.

This ſpecies is compoſed of a baſis which appears to be of the nature of wacken.

Colour—Browniſh or light yellow, by decompoſition acquires a white tegmen.

Luſtre—None.

Tranſparency—None.

Hardneſs—Cannot be ſcraped with a knife, and hardly gives fire with ſteel.

Fracture—Uneven earthy, ſometimes fine ſplintery.

FELTSPAR.

Is of a browniſh colour, ſometimes white and cryſtallized.

QUARTZ.

Is of various colours, white, yellow or ſmoke, of different ſhapes, angular, rounded, or regularly cryſtallized, preſenting here and there ſix-ſided pyramids; it is alſo ſometimes diſperſed through the baſis in the form of ſtrings.

PORPHYRY, from Glen-Cloy.

The baſis of the porphyry found in this glen, differs, in general, but little from that of Cory-gills; in particular inſtances, however, we obſerve a conſiderable difference of appearance, marking the gradations of the baſe, and the different proportions of feltſpar and quartz. In ſome ſpecimens, the quartz entirely diſappears; a few ſpecks of feltſpar only remain, immerſed in a baſis which is more of the nature of indurated clay than of wacken. This baſis is of a lavender blue colour, with an earthy fracture, without luſtre or tranſparency, and yields pretty eaſily to the knife. Not unoften the porphyry is ſhiſtoſe, and frequently the ſhiſtoſe porphyry, or ſiliceous ſhiſtus of Mr Kirwan, is to be obſerved having the following characters.

Colour.—Grey, or greyiſh black.

Luſtre.—None.

Tranſparency.—Tranſmits a very little light at the edges.

Hardneſs.—Gives fire plentifully with ſteel.

Fracture.—In the groſs, ſlaty; of the ſingle plates, more or leſs fine, ſplintery, inclining to the even.

The feltſpar is ſeldom to be obſerved, but the quartz frequently occurs.

GRANITE.

The granite of this iſland is, in general, pretty compact, of a whitiſh brown colour, owing to the ſlight brown tinge of the feltſpar. To deſcribe all the varieties that occur, might be uſeful, but that is more adapted for a ſyſtematic treatiſe of mineralogy, than an outline of this kind. I ſhall only, therefore, give a particular account of two ſpecies, the great grained, or common ſpecies, and the ſmall grained.

1ſt. GREAT GRAINED GRANITE. This ſpecies is not only remarkable, by its forming a very conſiderable part of the ſolid materials of the iſland, but alſo on account of the peculiarity of its compoſition; as it frequently contains three ſpecies of feltſpar, and the quartz is often cryſtallized.

1ſt Species, **FELTSPAR.**—Is of a white colour, with a ſlight tendency to the brown, having the uſual luſtre, tranſparency, fracture, and hardneſs.

2d Species ADULARIA? *Colour*, White.

Form.—Either in amorphous maſſes, or cryſtallized in hexahædral priſms, bevelled at both ends.

Luſtre.—External, like that of cryſtals not much poliſhed. Internal, ſame.

Tranſparency.—Sometimes objects can be ſeen pretty diſtinctly through the cryſtals, but when they are a little decompoſed, opacity is produced.

Fracture.—Plain foliated, and ſometimes ſtriated.

Hardneſs.—Gives fire plentifully with ſteel.

Fuſibility.—At 100° the ſurface was formed into a yellow coloured enamel.

3d Species. Is of a white colour, having nearly the uſual hardneſs, fracture, &c. of the common feltſpar, differing principally in the luſtre, which is like that of poliſhed metals, reflecting, in certain directions, a ſilver light.

Quartz. Is frequently colourleſs, alſo greyiſh, pale yellow, pale, or dark brown, and ſometimes nearly black, when it is called *Marion*.

Is very often cryſtallized, and either in the form of hexangular priſms terminated by hexangular pyramids, at one or both ends, and the priſms are ſeamed acroſs. The cryſtals are ſometimes found ſeveral inches long, and from two to three inches diameter, of a pale brown, or rather ſmoke colour. Theſe laſt are much valued by the Lapidaries.

Mica. Is often black, ſometimes golden yellow, tombac brown, or green. It is generally in the form of irregular plates; and pretty frequently hexagonal plates occur, which being ſuperimpoſed upon each other, form a hexagonal figure, of ſome magnitude.

The conſtituent parts of the granite, are very various in their proportion; but, in general, the feltſpar forms the moſt conſiderable part; then the quartz, laſtly the mica.

2d SMALL GRAINED GRANITE. Is very compact, with an uneven fracture, compoſed of feltſpar and quartz, in nearly equal proportions, with very few ſcales of black mica. It is ſubject to much variety, not only on account of the ſize of the particles, but alſo from the relative proportion of the ingredients, their degree of compactneſs, &c. Some varieties are ſo compact, and have ſuch a general appearance, as eaſily to paſs for ſandſtone; but a careful examination of the figure of the particles, the want of ſubſtramen, or baſis, and laſtly, its ſituation in the earth, afford ſufficiently diſtinct marks of difference. It is generally found in fiſſures, which traverſe the great grained granite, in all directions; but it alſo occurs in patches diſperſed through the common ſpecies*.

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* It has been obſerved in the mountains of the Hartz, that granite affects the magnetic needle; but it acts only in maſs, and in a perpendicular vein—Detached pieces ſhow no action upon the needle.

MICACEOUS SHISTUS.

SHISTOSE MICA, Kirwan; Lepidotis, Dr Walker; Glimmer Schiefer, German.

It would be tedious to deſcribe the different ſpecies of micaceous ſhiſtus, that are to be found in this iſland. I ſhall, therefore, only make a few general obſervations. It is, in general, very compact, and often ſo much ſo, as to break into angular fragments, with little tendency to the ſhiſtoſe form. The mica is of various colours, but generally greyiſh; it alſo differs in its proportions; the ſcales are, in general, ſmall, in no inſtance being ſo large, as in the generality of ſpecimens, in Shetland. In ſome inſtances the ſcales are not diſtinguiſhable; and then it has a lead colour, and often verges towards Ardeſia, particularly ſome of the ſpecies, in Glen-Halimidel, and Loch-Ranza. The quartz is alſo very various, not only in its proportion, but alſo in its colour and mode of diſtribution. When it is in conſiderable proportion, and very intimately mixed with black mica, it is difficult to diſtinguiſh it, at firſt ſight, from ſome ſpecies of baſalt. In no inſtance did

I obſerve hornblende, garnet, actynolite, ſappare, ſhorl, or calcareous ſpar mixed; but ſometimes the talcerde of Werner, was intermixed with the mica.

BRECCIA.

I have already remarked, that the common breccia, which runs amongſt the ſandſtone, is formed of fragments of ſandſtone and quartz, immerſed in an arenaceous baſis. Another ſpecies occurs upon the ſummit of the Scenite hills, back from Glen-Cloy. It has an arenaceous baſis, approaching, in appearance, to baſalt, and containing rounded, or angular maſſes of granite, ſimilar to that of Goatfield, micaceous ſhiſtus, quartz, porphyry, the ſame with that of Glen-Cloy, baſalt and hornſtone. I was not able to diſcover its real ſituation, but its compoſition ſhowed, that it was probably interſperſed between the primary and ſecondary ſtrata. The circumſtance of its containing granite, explained a phenomenon, which long puzzled me, the appearance of rounded maſſes of granite, upon the ſummit of ſeveral high hills; theſe evidently owing their origin to the decompoſing breccia.

ARRAN.

CHAP. III.

CORY, COCK OF ARRAN, AND LOCH-RANZA.

HAVING now given a pretty extended deſcription of the ſtrata and minerals in the neighbourhood of Brodick bay, we ſhall, in the next place, proceed to trace the ſtrata round to Loch Ranza; which is ſituated upon the north-weſt ſide of the iſland.

From Brodick bay, the cliffs all round are low, and for a great way compoſed of the uſual red ſandſtone, which is much traverſed by veins of baſalt, of various widths, and running in many different directions. Coves occur in ſeveral places, but none are of conſiderable ſize; frequently calcareous ſtalactites hang from their roofs. The action of the ſea upon the ſandſtone, has given a ſingular aſpect to the whole ſhore, owing to the more ſoft ſandſtone being waſhed away, whilſt the more compact and hard, which appears to have been formed in figures, is left ſtanding in ſhort ridges, or criſtæ. The ſandſtone, as it riſes upwards, forms part of the lower region of Goatfield, in the vicinity of the micaceous ſhiſtus, which it, in all probability, covers. About a mile from the Cory, about one hundred feet above the level of the ſea, there is a ſtratum of limeſtone, about twelve feet thick, running at an angle of about 20°. This is covered with red coloured ſandſtone; but below, interſperſed between the limeſtone and ſandſtone, there is a layer of a red ſhiſtoſe clay. This ſtratum has a ſingular aſpect, owing to its being divided into a number of ſtratulæ, by means of interpoſed ſhiſtoſe clay; In this clay we obſerve regular ſeries of ſhells, depoſited in layers (all appearing of the ſame ſpecies) with their convex ſides invariably downwards. The ſtratum is ſometimes ſtreight, but is often waved and twiſted. It alſo frequently contains radiated calcareous cryſtals, which are of a reddiſh colour, owing to the admixture of iron. In a fiſſure of the ſandſtone, above the limeſtone, I obſerved ſtalactites of peat, of conſiderable ſize and conſiſtence, which appear to have been formed by the infiltration of the ſoluble peat-matter through the ſandſtone. Immediately above this ſtratum, at ſome diſtance, is the rugged, ſteril-looking Cory-glen, which lies upon one ſide of Goatfield, running nearly eaſt ſouth-eaſt. It is very precipitous on all ſides, is broader than any glen in the Goatfield groupe, but is comparatively ſhorter, and its bottom is higher than that of Glen-Roſa, but not ſo much elevated as that of the Cory-dain or Feun-hody. It is entirely compoſed of granite, which is here ſplit, as uſual, into immenſe blocks, that are piled in vaſt tumuli upon the tops of the ſurrounding mountains, or cover the ſides and bottom of the glen, as with ruin and deſolation. But to return: upon leaving the limeſtone ſtratum, and going towards the Cory, we obſerve, upon the ſea ſhore, a vein of ſoft red ſhiſtoſe ſandſtone, containing rounded pieces of argill, running through the ſandſtone, north-eaſt and ſouth-weſt. At the Cory, where there are a few houſes, we obſerve quarries of ſandſtone, of a beautiful white colour, and of good conſiſtence for building. Theſe quarries are now worked by a company, for the conſtruction of the Crinan Canal. Here there is alſo

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a ſtratum of limeſtone, about thirty feet thick, conſiderably inclined to the horizon, running north north-weſt, and ſouth ſouth-eaſt, and divided into ſtratulæ, as the ſtratum formerly mentioned, with intervening clay and ſhells, but the clay is more or leſs indurated. From this towards weſt Sanicks, the ſhore is compoſed of the common red coloured ſandſtone, interſected here and there with veins of baſalt; but it is often ſo covered with bowlder ſtones of different kinds, as to render travelling very difficult. The rounded maſſes of granite, ſcattered up and down here, are of a moſt aſtoniſhing ſize; ſome of them hundreds of tons weight. Near to the Sanicks, there are immenſe ſtrata of breccia, which is compoſed of rounded fragments of quartz, and micaceous ſhiſtus, cemented by an arenaceous ground. The breccia is in many places much broken. Immenſe maſſes of it, many thouſand tons weight, lying ſeparated from the ſtrata only a few feet, render it probable, that theſe maſſes were diſunited by froſt. In one place, I obſerved, a conſiderable ſection of the breccia, which I examined very carefully, in order to diſcover if the maſſes of quartz, were compreſſed and ſmaller at the lower than the upper part, but I could not obſerve any difference. A very remarkable inſtance of this kind has been obſerved in other countries; thus in Bergm. Erde-Beſch. 182, we are told that in the mountains of Quediliæ and Portfiællet in Norway, which conſiſt of an argillaceous puddingſtone, the ſiliceous pebbles it contains, are obſerved to be compreſſed to the thickneſs of the fourth of an inch, in the lower parts of the mountains, but to increaſe in ſize and roundneſs in proportion as their ſituation is higher. Alſo in the Vivarois, the loweſt ſtrata of primitive limeſtone, have been found of the thickneſs of one-tenth of an inch; but in proportion to their elevation in the mountain their thickneſs increaſes, until at its ſummit, it arrives at thirty or forty feet. 1. Soulavie, 178. Ferber made the ſame obſervation in England.

At a little diſtence from the ſhore, is the entrance into the deep Glen-Sanicks, which is about four miles long, running nearly eaſt and weſt, bounded on both ſides by lofty mountains: on the north, the Cairns, with part of Cairn-na-callich; and towards the ſouth, Keich-na-hein and

Goatfield, form boundaries awfully grand. The ſides of the glen are much furrowed by the action of the rain. This circumſtance, with the red colour of the decompoſing granite, the immenſe blocks that cover the ſides and tops of the mountains, form altogether a ſteril and tremendous ſcene.

———In lonely regions, here retired
From little ſcenes of art, great Nature dwells
In awful ſolitude.

Here we obſerve ſeveral veins of baſalt traverſing the granite, and in ſome places we can trace the perpendicular veins, from the bottom to the top of the mountains. At the top of this glen is the hollow called Cory-na-huave, which is bounded by Cairn-na-calligh and Keid-voe. Its bottom is higher than that of Glen-Sanicks, and is all compoſed of granite, penetrated with veins of baſalt, ſome of which have a conſiderable degree of curvature. The water from the ſurrounding mountains is collected in this hollow, and ruſhes over its elevated bottom into Glen-Sanicks, through which it paſſes. Before reaching the ſea, it forms a conſiderable ſtream, named Sanicks-burn, which is filled with bowlder-ſtones, from the neighbouring mountains. After paſſing this burn, we find the ſandſtone, breccia and baſaltic veins ſtill continuing, but the appearance of the mountains is much changed; the peaked ſummits, and almoſt perpendicular furrowed ſides, now diſappear; the mountains are clothed with heather to their ſummits, which are more or leſs round-backed, intimating an alteration in the materials of which they are compoſed, which is really the caſe, as the granite has now diſappeared, the ſummit of the largeſt hills being of micaceous ſhiſtus. We now wander along a mile or two of ſhore compoſed of ſandſtone, when our attention is arreſted by the remains of workings for coal, at a little diſtance from the famous ſea mark, the Cock of Arran. This ſtratum which is but of ſmall extent, runs in the ſandſtone accompanied by the uſual coal metals, as they are called, and at the bottom of a mountain of micaceous ſhiſtus. It is of that kind which is found at Kilkenny in Ireland, and is called in this country Blind Coal.* I obſerved two pits, about fifteen feet deep, which had been dug in cutting the coal ſtratum; but as the coal ſoon diſappeared, the pits were left, and the ſalt pans which had been erected, were rendered uſeleſs. The ſituation of this ſtratum is ſuch, as to preclude all hopes of finding any conſiderable quantity of coal, although freſh ſections were made; for we invariably find it to be the caſe, that wherever coal ſtrata come into the vicinity of high mountains, they then moſt certainly decreaſe in breadth, and become bad, owing to the great admixture with earthy matter. It is nugatory to ſay that the ſtrata will be found in the oppoſite ſides of the mountains; this is never the caſe, nay even in low baſaltic hills, we do not find the ſtrata on the oppoſite ſide, as they are there only to be obſerved riſing to a conſiderable height upon the hills, and never in Scotland above eight hundred feet. The great frequency of baſaltic veins is another cauſe, which muſt

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* Dr Hutton conceives, that this ſpecies of coal preſents an irrefragable proof of the truth of his theory. Here, ſays he, is a coal having all the properties of that which has been ſubmitted to the

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the action of heat; the bitumen is ſeparated, and charcoal remains. To the Neptuniſts, this affords one of the ſtrongeſt facts againſt the theory; the ſeparation of bituminous matter ſhows a want of immenſe compreſſion, which is the grand fundamental baſis of the hypotheſis; it is indeed this circumſtance principally which diſtinguiſhes it from the Volcanic Theory, and has led Mr Kirwan to name this the *Plutonic*.

muſt render the coal, if it ſhould ever be detected, of an indifferent quality and difficult to work.

From this ſtratum to the Cock, which is the moſt northern point of the iſland, the ſhore is covered with immenſe maſſes of ſandſtone and breccia, which have tumbled from the neighbouring hills, by the action of the weather. *Ironſtone is found ſcattered upon the ſhore, and is probably connected with the coal workings. The Cock is not, as I expected, a great headland, but merely an enormous maſs of ſandſtone, lying looſe upon the ſhore, having a fancied reſemblance to the head of the Cock. Here the cliffs are of conſiderable height, compoſed of ſandſtone and breccia, traverſed with veins of baſalt of various ſizes; one of theſe veins is compoſed of a curious matter, reſembling porphyry, and towards the ſides, where it is in contact with the ſandſtone, it

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* Dr Hutton imagines that thoſe ironſtones which paſs by the name of Septaria, afford diſtinct marks of having been formed from a ſtate of fuſion. All this is founded upon a partial examination of the appearances; it is ſaid that we cannot perceive the ſpathoſe matter, entering from without; this however is a very common appearance, of courſe the Doctor's explanation falls to the ground.

it is hard, and much reſembles hornſtone. After leaving this, an aſtoniſhing appearance preſents itſelf to our view, of the whole face of an immenſe ſtratum of breccia, which was torn to pieces, and rolled towards the ſea, by the intenſe froſt two years ago; the craſh of its fall was heard far off. The ſandſtone upon this part of the ſhore has a curious appearance; the ſtrata are alternated with layers of ſhiſtoſe clay, and have the appearance of a regular pavement, being formed into two, four or ſix-ſided irregular figures, connected together by the clay, which being decompoſed, leaves the ſandſtone lying upon the ſhore in irregular ſhaped pieces, which have much the appearance of art. From this to within a mile of Loch Ranza, the ſandſtone, as uſual, forms the cliffs upon the ſhore, and is backed by mountains of micaceous ſhiſtus, upon which it reſts. Here however the ſandſtone diſappears, and the micaceous ſhiſtus now forms the cliffs, which become higher as we approach Ranza. At this place, I expected to find the baſalt penetrating the micaceous ſhiſtus, as Dr Hutton remarks, and was not diſappointed; for, at the place where the ſandſtone diſappears, there is a great baſalt vein, about thirty feet wide, running in the micaceous ſhiſtus, which is here ſo compact, as to be difficultly diſtinguiſhed from the baſalt. As we approach nearer to Loch Ranza, the ſea has expoſed ſeveral other ſimilar appearances, but far more diſtinct than the firſt. Theſe veins are of various ſizes, ſome are curved in their direction, one in particular, is forked, or divided into two branches, which run in very different directions through the micaceous ſhiſtus. A few hundred yards from the entrance of the Loch, the ſea has formed an intereſting ſection of the ſtrata, which demonſtrates, in a ſatisfactory manner, the relative poſition of the ſandſtone, limeſtone, and micaceous ſhiſtus. A large baſalt vein, between ten and twelve feet, is to be obſerved traverſing the micaceous ſhiſtus, with a ſlight degree of curvature. At the extremity of the vein, viſible at low water, we obſerve the baſalt covered with micaceous ſhiſtus. Immediately above this is a ſtratum of limeſtone, which contains rounded fragments of a kind of hornblende, and above this is the ſandſtone, all running at the ſame angle. Many other veins may be obſerved traverſing the micaceous ſhiſtus, before we arrive at the entrance of Loch Ranza, but any detailed accounts of theſe would be but a repetition of what has been already mentioned.

GLEN-RANZA.

This glen is about two miles long, and half a mile broad, running nearly north and ſouth, bounded on both ſides by lofty round-backed mountains, that riſe at a very conſiderable angle, and are nearly of the ſame height on both ſides of the glen. The inclination of the oppoſite mountains is the ſame, and the ſtrata run at the ſame angle. The bottom of the glen is but little elevated, being nearly level; about one half is covered with a ſalt water loch, which adds greatly to the beauty of this romantic ſpot. The hills are compoſed of micaceous ſhiſtus, containing a greater or leſs proportion of quartz and mica; indurated chlorite is alſo diſperſed through it, and towards the mouth of the loch there is a conſiderable ſtratum of ardeſia, or primitive argillaceous ſhiſtus. Primitive limeſtone occurs upon one ſide of the loch, but I had not an opportunity of examining its ſituation.

From the top of Glen-Ranza, we enter, by a narrow paſſage, into a long deep glen, running nearly in the ſame direction, called Glen-na-birach, bounded, on both ſides, with mountains of micaceous ſhiſtus, which lie upon the granite. On advancing further up the glen, the micaceous ſhiſtus diſappears, when both ſides are formed of granite, of the ſame kind as that from Goatfield. The bottom is alſo formed of granite, as is well demonſtrated by the ſtream, or burn, which has laid bare the rocks through the whole extent of the glen; it is indeed by rivulets of this kind that we are enabled often, to have a diſtinct view of the mineral ſtructure of highland countries. From the further extremity of this glen, is the aſcent to Cairn-na-cailligh, which is in ſeveral places rugged and difficult, from the number of looſe blocks of granite ſpread all around. Upon aſcending, we firſt ſtop at the edge of what is called the Gariſe-hodie. Here a wonderful and moſt tremendous ſcene preſents itſelf to our view. An immenſe hollow, many hundred feet deep, dreadfully rugged and broken, almoſt entirely ſurrounded with mountains, whoſe ſerrated ſummits are covered with immenſe tumuli of granite, exhibits to us, in very legible characters,

racters, the vaſt operations of nature, in the formation and decompoſition of our globe. What man, poſſeſſed of reaſon, contemplating this awful ſcene, could doubt of the exiſtence of that BEING, whoſe power and wiſdom are far beyond the reach of human comprehenſion? If ſuch a man exiſt, vanity, not ſoundneſs of judgment, is the diſtinguiſhing feature of his character. Few, indeed, of thoſe who deny, or even doubt the exiſtence of Deity, have ever beheld, far leſs ſtudied, the ſtupendous and awful works of nature. It is not, then, much to be wondered at, that the pride and arrogance, which ſo often characteriſe the cloſet philoſopher, ſhould find their way to mix with the moſt daring and impious ſpeculations; ſpeculations, which have for their end the propagation of the worſt principles, the diſſolving of all the bonds, and deſtroying the ſweeteſt endearments of human ſociety.

Upon the edge of the hollow, I obſerved ſeveral fragments of porphyry, but I could not diſcover any fixed rocks of it, owing to the blocks of granite ſcattered all over the ſides of the mountains. In aſcending from this, to Cairn-na-calligh, ſeveral other appearances of porphyry, and alſo fragments of baſalt and pitchſtone, preſented themſelves. After conſiderable fatigue I was ſo fortunate as to diſcover two veins of baſalt, upon the ſide of Cairn-na-cailligh, looking into the Gariſe-hodie; and, between theſe, there appeared a perpendicular vein of pitchſtone, all running in the common granite. This pitchſtone, is of a green colour, much reſembling that from Brodick wood. It forms a vein, about two feet wide, and, what is remarkable, it is formed into regular columns, from two to twelve inches in diameter, and having from three, to ſix irregular ſides. I could not, however, detect the ſituation of the porphyry, altho' it was ſcattered in ſome places of the mountains in conſiderable quantities. Having gained the ſummit of this great mountain, which is nearly of an equal height with Goatfield, we have a very extenſive view; and a better opportunity of obſerving the poſition of ſome of the glens, than even from Goatfield itſelf, particularly that of

GLEN-ERSAY.

This glen which is the largeſt in the iſland, is upwards of ſeven miles long; its ſides are lower and leſs precipitous than the glens about Goatfield, and the hills are round backed, having their ſummits covered with heather, marking the diſappearance of granite, and the preſence of micaceous ſhiſtus or ſcenite, but more likely the former, as the ſcenite does not form ſuch high hills in this iſland. The top of this mountain has a moſt ſingular appearance, owing to its being covered with enormous piles of quadrangular maſſes of granite, which have the appearance of artificial tumuli: This appearance is by no means peculiar to Cairn-na-calligh, for we have already remarked it upon the top of all the granite mountains in the iſland; only here the maſſes are of vaſt ſize, and placed upon each other in a moſt fantaſtic manner. Here we can trace the granite in its various ſtages of decompoſition, from the ſolid rock to the looſe ſand; in its beginning diſintegration the granite ſplits into maſſes, having a greater or leſs tendency to the quadrangular form; but theſe maſſes have ſtill a degree of connection amongſt themſelves, as is the caſe upon the mountain top. The next ſtep is the enlargement of theſe fiſſures, by which the maſſes are looſened from their connection, and tumble down from their elevated ſituations, or are hurried with impetuous velocity down the mountain ſide, covering the bottom of the glens with their ſtupendous ruins. Laſtly, theſe detached maſſes, by the action of the weather, are completely diſintegrated, forming a looſe ſand, which is left upon the tops or ſides of the mountains, and is carried in great quantities to the ſea ſhore by the torrents *. Sauſſure, at ſection

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* Dr Hutton remarks, that the ſtony matter of this globe has been formed by the decay of a former world, whoſe debris has been collected by various means, at the bottom of a former ocean. This part of the Huttonian theory differs but little from that of Count Buffon: it includes, however, the queſtion concerning the divinity of the world; a ſpeculation, fit only for fanciful metaphyſicians. Leaving, therefore, ſuch abſtruſe and uſeleſs quiblings, let us examine matter of fact. Here, however, we are diſappointed; not a ſhadow of proof is brought of the debris being carried to the bottom of the ocean; on the contrary, we obſerve the decompoſing materials of mountains filling up hollows, or forming plains. In the other inſtances, the debris is carried to the ſea ſhores, (as in the caſe mentioned above) where it is mixed with the waters of the ocean, and latterly thrown back upon the ſame or other ſhores, forming great tracts of land. Thus, the lands of Holland, the delta at the mouth of the Nile, are remarkable examples of this fact. The town of Damietta, in lower Ægypt, about the year 1243, was upon the ſea ſhore, but is now above twelve miles from it; the town of Fooah, which, three hundred years ago, was ſituated at the mouth of the Nile, is now ſeven miles diſtant from it.

tion 604 of his Voyages dans les Alpes, remarks, that granite is diſpoſed in ſtrata, but that they are not always to be diſtinguiſhed, particularly in the granite of low countries and plains. This he conceives to be owing to the granite of low hills, containing a great quantity of pierre de corne *. This pierre

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it. The country about the Baltic is gradually incroaching upon the ſea. Linnæus remarks that the ſea ports of eaſt and weſt Bothnia, are every year decreaſing, and becoming incapable of admitting veſſels; the inhabitants of the ports are obliged to change their ſeats, and ſometimes remove a quarter of a mile nearer the ſea. On the eaſtern ſide of Goth-land, near Hoburg, the increaſe of the continent for theſe laſt ninety years, is about two or three toiſes annually. The inhabitants of weſt Gothland remark that the ſea decreaſes every ten years four or five lines perpendicularly, which, amounts, to forty or fifty lines in a century.

According to this calculation, 600 years ago the ſea was 25 inches deeper than it is at preſent. In Arran we have alſo a ſtriking proof of the formation of land by the accumulation of debris. Innumerable other inſtances might be mentioned, but theſe are ſufficient to demonſtrate the formation of land, without the ſuppoſition of the debris being carried to the fathomleſs depths of the ocean, and ſubjected to intenſe heat.

* It is difficult to ſay, in this inſtance, what particular foſſil is here alluded to, as Sauſſure under this name, confounds Baſalt, and Hornblende. In one of the late volumes of his travels, he remarks, that wherever Pierre de Corne occurs criſtalliſed, it is called Hornblende. All this, however, does not clear up the preſent difficulty.

pierre de corne, he continues, contains a great proportion of argillaceous earth; and as moſt ſtones, which have this earth, as a conſtituent part, and in conſiderable proportion, ſplit into rhomboidal maſſes, ſo he concludes that it is the earth of pierre de corne which is the cauſe of the ſplitting of granite, forming the numerous maſſes, which prevent us from obſerving the ſtrata. This explanation, however ingenious, does not hold true with regard to the granite of this iſland; no argillaceous ſtone of that kind enters into its compoſition, yet ſtill it ſplits into rhomboidal maſſes.

GLEN-HALIMIDEL.

Upon the eaſt ſide of Glen-Ranza, there is an opening leading to a glen, named Halimidel, which is about two miles long, running W. N. W. and E. S. E. but which ſoon changes its direction, running nearly in a line with Es-na-birach. It is narrow at the bottom, but widens upwards, owing to the inclination of the ſides, which form an angle of about 60°, and the bottom alſo riſes, forming a conſiderable angle with the ſides. It is compoſed of various ſpecies of micaceous ſhiſtus, indurated chlorite, ardeſia, or argillaceous ſhiſtus and quartz. In ſeveral places baſalt veins may be obſerved traverſing the micaceous ſhiſtus, many hundred feet above the level of the ſea, even in the bottom of the glen, where the burn has expoſed the micaceous ſhiſtus, we obſerve baſalt veins croſſing it. Upon the eaſt ſide of the glen, ſeveral hundred feet above the level of the ſea, there are two quarries, which were formerly worked for ardeſia, but are now diſcontinued. The ardeſia is of various colours, generally bluiſh green, intermixed with white quartz, and the fiſſures often contain cryſtals of actynolite, and a ſpecies of quartz, penetrated with actynolite, or what may be called *Praſe.*

ARRAN.

CHAP. IV.

DESCRIPTION OF THE FOSSILS, OCCURRING IN THE PRECEDING CHAPTER.

LIMESTONE CORY.

Colour.—Grey.

Luſtre.—A very faint degree of luſtre.

Tranſparency—None.

Hardneſs.—Scrapes eaſily with a knife, emits a ſtrong earthy ſmell.

Fracture.—Even, fine, ſplintery, and very compact.

Fuſibility.—At 140° Wedgewood, no appearance of fuſion.

Another ſpecies is alſo found at the Cory, of a brown colour, minute foliated, difficultly ſcraped with a knife, and wanting tranſparency.

LIMESTONE near the Cock.

Colour.—Brick red.

Luſtre.—A ſlight degree of luſtre from ſome diſperſed foliæ.

Tranſparency.—None.

Hardneſs.—Pretty difficultly ſcraped with a knife.

Fracture.—Generally foliated, paſſing to the compact earthy.

INDURATED LITHOMARGA ?

Colour.—Pink ?

Luſtre.—None.

Tranſparency.—None.

Hardneſs.—Yields to the knife with conſiderable difficulty, gives a pink ſtreak.

Fracture.—Even, bordering upon the fine ſplintery. Does not ſtain the finger. Feels dry; does not ſtain the fingers, nor acquire a poliſh by friction. After immerſion in water for two days, no appearance of diſintegration.

BASALT, from a vein near the SANICKS.

Colour.—Greyiſh green.

Luſtre.—None.

Tranſparency.—None.

Fragments.—Uneven earthy.

Hardneſs.—Pretty eaſily ſcraped with a knife.

Fuſibility.—Melted at 58°.

COCK COAL.

Colour.—Black; when freſh broken, ſometimes reflects a golden yellow, or violet colour.

Luſtre.—Is that of metals not much poliſhed.

Hardneſs.—Yields rather with difficulty to the knife.

Fracture.—Plain foliated.

Is not coated with whitiſh illinitions, as that from Kilkenny in Ireland. It does not ſtain the fingers.

Hardly burns until wholly ignited; when it conſumes ſlowly, with a ſlight lambent blue flame;

which continues for a ſhort time. According to Mr Kirwan's method, it contains in the 100 parts, 93 of carbon, and 7 of aſhes.

Mr Kirwan, in the ſecond volume of his Mineralogy, remarks, that coals are not ſoluble in acids. I have obſerved, however, that they are all rendered completely ſoluble in water, by means of the nitrous acid, the carbonaceous baſis appearing to be converted into an oxyd.

ARDESIA.

Argillite, Mr Kirwan. Primitive argillaceous Shiſtus.

Colour.—Greyiſh blue, or greyiſh green, ſometimes both colours are intermixed in the ſame ſpecimen.

Luſtre.—Silky.

Tranſparency.—None.

Fracture.—Streight, ſlaty.

Fragments.—Tabular.

Hardneſs.—Yields pretty eaſily to the knife.

Streak.—Grey.

Does not adhere to the tongue, feels rather greaſy, particularly the green coloured; does not ſtain the fingers. There are often interſperſed in the fiſſures, cryſtals of glaſſy actynolite.

ARRAN.

CHAP. V.

GLEN-CATACOL, SHISKIN, TORY-LIN, BENIN-HEAD, WHITING-BAY, LAMLASH-BAY, LAMLASH-ISLAND.

HAVING ſurveyed the glens and ſtrata in the neighbourhood of Loch-Ranza, we ſhall now proceed around the iſland by Glen-Catacol, which is about a mile and a half from Ranza. The ſhores are bounded by cliffs, which are not very high, or rugged, but beautifully adorned with low ſhrubs, giving a richneſs of appearance, ſeldom obſerved upon the barren ſhores of this iſland. The cliffs and mountains in the vicinity are formed of micaceous ſhiſtus, of various degrees of hardneſs, owing to its being more or leſs intermixed with quartz; they are ſeparated from the ſea by low beaches, of conſiderable extent, which, in ſome places, are cultivated. The entrance to the glens is bounded by lofty, precipitous, mountains of micaceous ſhiſtus; but this ſoon diſappears, as the glen changes its direction, running N. N. E. and S. S. W. Then the mountains are formed of granite, ſimilar to that of Goatfield. In ſeveral places of the glen, fragments of baſalt occur, demonſtrating the preſence of veins penetrating the granite, as we have already obſerved, upon Cairn-na-calligh, and Glen-Roſa. At the top of the glen, in a conſiderable plain, is ſituated Loch-Tannoch, which is about a mile long, and half a mile broad, elevated ſeveral hundred feet above the level of the ſea. It is bounded upon two ſides, by lofty granite mountains, but is open towards the others, one leading to Glen-Erſay, the other to Catacol. The margin of this lake partakes much of the ſterility of the ſurrounding ſcenery; vegetation hardly ſhews its head; a few lichens and tufts of heather are the only ornaments of which it can boaſt.

———————— A joyleſs coaſt,
Around a ſtormy lake, ————————

Yet here the grandeur and ſublimity of the ſurrounding granite mountains, enveloped in clouds and miſt, excite in our minds a vaſt variety of ideas; for,

Surely there is a hidden power that reigns,
'Mid the lone majeſty of untamed nature,
Controlling ſober reaſon ——

Upon aſcending the granite mountains on the eaſt ſide of the loch, I obſerved conſiderable quantities of the debris of baſalt veins upon the top of the mountains, ſhowing that they had penetrated the granite hills to the very ſummit. In deſcending from theſe mountains, we enter into a glen of ſome extent, running in an oppoſite direction from Catacol, but falling into it near its entrance. Upon the ſides of this glen, which are of granite, great maſſes of porphyry were ſcattered, but I could not detect any in ſitu; it is probable, however, that it forms veins running through the granite, as the quantity of debris is too ſmall for ſuppoſing the exiſtence of ſtrata[*].

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[*] Dr Hutton remarks, that "Granite is a compound, which "graduates into porphyry; but porphyry is only a whinſtone, of "a harder ſpecies. Therefore, though perfectly diſtinct, theſe "three things graduate into each other, and may be conſidered as "the ſame." This rapid concluſion cannot be admitted: baſalt, it is well known, has uſually a uniform appearance with a ſplintery or conchoid fracture, it ſometimes contains cryſtals of feltſpar, and hornblende, forming a ſpecies of porphyry, which is not harder than

From Catacol to Whitefarland, a farm belonging to Fullerton of Kilmichael, the cliffs are low, compoſed of micaceous ſhiſtus, but defended from the action of the ſea, by intervening ſea banks, ſimilar to thoſe noticed between Catacol and Loch-Ranza. Near to the farm of North Tundergay, I obſerved a remarkable vein of baſalt, penetrating the micaceous ſhiſtus. The micaceous ſhiſtus is much waved, but as it approaches the ſide of the vein, it loſes its ſhining glimmery appearance, becomes more ſolid and compact, breaks into thick plates, and where in immediate contact with the baſalt, it is difficultly diſtinguiſhable from it. The vein, as it riſes from the ſea, is fairly croſſed by a ſpecies of micaceous

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baſalt; indeed we frequently obſerve the ſame maſs, in part porphyry, and part baſalt. That granite graduates to baſaltic porphry, no one has ever demonſtrated, and we muſt believe that ſuch an appearance is ideal, founded upon falſe reaſoning. We might as well ſay, according to the Huttonian language, that granite graduates into ſerpentine, becauſe we obſerve ſerpentine porphyry, or into hornſtone, becauſe we obſerve hornſtone porphyry, or into pitchſtone, becauſe we obſerve pitchſtone porphyry. It may be anſwered to this, that Dr Beddoes has determined the gradation of baſalt into granite; to me, however, this has as little probability as the other, for as far as I have examined, no ſuch gradation is to be obſerved near Edinburgh, where Dr Beddoes ſays he noticed it.

micaceous ſhiſtus, approaching to breccia; and here alſo the baſalt and micaceous ſhiſtus are much jumbled together, and ſome pieces of the vein are diſtinctly inſulated in the micaceous ſhiſtus. Here then we have two facts, the former the apparent tranſition from baſalt to micaceous ſhiſtus, or micaceous ſhiſtus to baſalt; the other, maſſes of the baſalt immerſed in the micaceous ſhiſtus, in a ſimilar manner to the baſalt we obſerved embedded in the granite, upon the ſide of Glen-Roſa. At Whitefarland, there is a conſiderable extent of natural wood, which adds greatly to the beauty of its appearance, which is much heightened by the lofty mountains that bound it on one hand, with the ſea and long extended iſthmus of Cantyre on the other. From this to Imachar, the ſame micaceous ſtrata continue, forming beautiful cliffs and conſiderable ſea beaches. At Imachar, the micaceous ſhiſtus is much twiſted and traverſed with quartz, ſo as to give the whole a kind of maculated aſpect; and it continues to form cliffs, until we come to the ſtream which runs down from Glen-Irſa. Here the micaceous ſhiſtus, indurated chlorite, argillite, and other alpine rocks diſappear; when croſſing the ſtream, the ſandſtone preſents itſelf to our view. A very conſiderable ſea beach, covered in part with graſs, is interpoſed between the ſandſtone and the ſea; and the ſtrata of ſandſtone, from the ſituation in which I viewed it, appears to be more elevated than any I had obſerved in the other parts of the iſland, and the retreat of the ſea is ſtrongly marked by the caves which are diſperſed in theſe cliffs. Theſe cliffs, however, continue but for a ſhort way; for, upon arriving at Machry-Bay, we find it bounded by the low ſhores, and the plain of what is called the town of the Shiſkin. At the Shiſkin, the land is low and flat; the mountains in the neighbourhood have a different appearance from thoſe about Loch-Ranza; are lower; their ſides leſs precipitous; in ſhort, have much of the general aſpect of thoſe about Glen-Cloy, all announcing a change in their compoſition, which, upon examination, we find to be the caſe. The Clachan glen, which is but a ſhort diſtance from the Shiſkin, is compoſed, as far as I examined, of ſandſtone and breccia of the common kinds. Upon the ſummit of the ſouth ſide, I obſerved a conſiderable ſtratum of lime-ſtone, which is covered, and even intermixed in ſome places, with ſandſtone and breccia. As the glen winds upwards, the hills,

hills become higher, being in all probability compoſed of ſcenite, penetrated with veins of baſalt, and porphyry, for we find the bed of the burn covered with bowlder ſtones of baſalt, porphyry and ſcenite.

About two miles north weſt from the Shiſkin, after paſſing through a mooriſh flat, we come to Drumoodon, which is the promontory of this plain. Here there are cliffs of conſiderable extent, which contain a range of extenſive caves, celebrated by tradition, as the reſting place of Fingal, the father of our Great Oſſian, who, it is ſaid, uſed to retire here after the fatigues of the chace. In the further extremity of the greateſt, or what is called the *King's Cove*, are a few ſcratches, made by idle fiſhermen, or ſmugglers, which, by ſome, have been referred to the Fingalian age.

As the appearances at this promontory are very intereſting, I ſhall begin the deſcription from the north eaſt end, or Machry-bay, and ſo on to Carbarn point, or the Baſaltic promontory. The bay is of conſiderable extent, and the ſhore all around to Irſa water, is formed of ſandſtone; the bottom of the bay is a low ſandy beach, but towards the promontory of Drumadoon it riſes, forming cliffs, which are continued all around to the Carbarn point, for the ſpace of about a mile and a half; and theſe cliffs are from forty to one hundred feet high *. The firſt object which ſtrikes the eye of the mineralogiſt is the great vein of pitchſtone, which is to be obſerved riſing from the ſea, and running eaſt north-eaſt, and weſt north-weſt, until it nearly reaches Machry-Bay. It is about ten feet wide as it riſes from the ſea, is of a green colour, like that upon the Lamlaſh road, and runs in the common red ſandſtone. Upon one ſide of the vein we can trace the gradual change of appearance in the pitchſtone as it approaches the ſtratified matter, forming a ſubſtance intermediate (if I may be allowed the expreſſion) between pitchſtone and ſandſtone; and in other parts veins of baſalt are to be obſerved running between the pitchſtone and ſandſtone.

In

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* Between the cliffs and the ſea, upon the beach, there are ſeveral remarkable appearances of baſaltic and other veins, which render this ſpot the more intereſting.

In tracing this vein, we obſerve it running for a conſiderable way without any interruption; at length a vein of baſalt, ſix or ſeven feet wide croſſes it, and riſes into the oppoſite ſandſtone cliffs; unluckily the meeting of the two veins is ſo covered with looſe ſtones, as to prevent any examination of their appearance. It is certain, however, that the pitchſtone is not changed in its direction, for it ſoon makes its appearance again from under the debris, when it can be traced for ſome diſtance uninterrupted by baſalt veins; at length it is croſſed by a great vein about twenty feet wide, which is ſeen traverſing the neighbouring ſandſtone cliffs. But this is not the moſt ſingular part of the appearance; here alſo the pitchſtone appears to ſend off a great branch, which riſes into the neighbouring cliffs, but its appearance is different from that of the great vein; it is in general more hard, its colours are various, and it approaches more or leſs to the nature of hornſtone. The further courſe of the pitchſtone cannot be at all diſcovered for a conſiderable way, as it is quite covered with debris, which is ſcattered upon the ſhore; but we obſerve ſix or ſeven baſalt veins running acroſs its direction, which can be traced into the neighbouring ſandſtone ſtrata for a conſiderable way. The pitchſtone now makes its laſt appearance, running ſtill in its original direction, but more diverſified in colour, hardneſs, &c. having much reſemblance to the great branch we before obſerved. A very conſiderable vein of green pitchſtone is now obſerved, riſing from the ſea, running in a croſs direction to that of the other vein; but their interſection or meeting is hid by the debris, which now prevents all further examination of their courſe or direction.

The next object which claims our notice, is the relative poſition of the ſandſtone and porphyry, a circumſtance which before engaged our attention in the deſcription of Glen-Cloy, and Cory-Gills. The cliffs beſide the ſandſtone, which forms their greater part, are in ſome places ſkirted by a porphyry, very ſimilar to that of Glen-Cloy, with the parts a little more diſtinct, and here and there penetrated with veins of baſalt. One vein, which is about ſix or ſeven feet wide, runs in the porphyry in a perpendicular direction, gradually narrowing towards the top of the cliffs, when it is loſt amongſt the ſandſtone, which lies immmediately behind the porphyry. Another vein is to be obſerved running in a different direction through the porphyry: as it enters the cliffs, it runs between the ſandſtone and porphyry. Theſe two veins can be traced in their courſe through the ſandſtone, for a conſiderable way in the level plain of the Shiſkin, each running in an oppoſite direction. Another vein, which is nearer to Machry-Bay than the other two, is to be obſerved running with porphyry on one ſide, and ſandſtone on the other: it ſoon divides, one branch penetrating the porphyry, the other running between the ſandſtone and porphyry. On the weſt of the King's-Cove, near the top of the cliffs, there is a conſiderable vein of pitchſtone, which traverſes the ſandſtone ſtrata, but it is ſo hid as to prevent any accurate knowledge of its ſize or direction. It differs, however, very much, in external appearance, from the other veins, not only in colour, but alſo in luſtre and hardneſs. At a little diſtance a ſtratum of porphyry, whoſe feltſpar is decompoſed to an ochraceous ſubſtance, reſts upon the ſandſtone, having a tendency to the columnar form. This continues until we arrive at the columnar promontory of Carbarn, near the farm of Drumodoon. On the way to this promontory, ſeveral veins of baſalt, ſome of them of conſiderable extent are obſerved traverſing the ſandſtone. Upon examining the connection of the veins and the ſtrata, I was ſurpriſed to find the baſalt and ſandſtone at their junction in ſeveral places intermixed with each other; and, what is curious, the veins of baſalt, beſides the angle they form with the horizon, have a conſiderable inclination of themſelves.

Having arrived at the promontory of Carbarn, we find it to be compoſed of a ſpecies of porphyry, forming columns not very regular, and ſtanding upon red coloured ſandſtone, the whole being nearly of the ſame height with the cliffs. The porphyry, in ſome ſpecimens, has exactly the appearance of baſalt porphyry, but in others it cannot be diſtinguiſhed from the wacken porphyry we have ſo often mentioned; and we alſo find that the wacken porphyry, where it is penetrated by baſaltic veins, has often the appearance of this ſpecies.

From theſe facts, it appears that the porphyry generally reſts upon the ſandſtone: they alſo ſhow a gradation or connection between baſalt, wacken and pitchſtone.

Having paſſed this promontory, we come to the farm of Drumodoon, which is ſituated upon the ſea ſhore, with a conſiderable ſandy beach before it; behind, the ſandſtone-cliffs are ſtill continued, but are now conſiderably lower, and ſoon diſappear altogether, being ſucceeded by an extenſive beach covered with fragments of the neighbouring rocks. Here we find, reſting upon the ſandſtone, a curious ſpecies of rock, intermediate between ſandſtone and baſalt, and having a tendency to the baſaltic form. After paſſing this beach, which forms one ſide of the plain of the Shiſkin, conſiderable cliffs now riſe before us, which are formed of wacken-porphyry of conſiderable height, but much ſplit by the action of the weather, which gives an indiſtinct idea of ſtratification, ſimilar to the granite obſerved in the Cory-Dain, at the head of Glen-Roſa. Theſe cliffs contain ſeveral caves, but none of them are of any conſiderable ſize, and the ſhore is covered with great maſſes, which have been ſeparated from the cliffs by the action of the ſea and weather. Theſe maſſes have a peculiarity of form, which characterizes the rock from which they have been ſeparated. This remark may appear fanciful, but ſeveral circumſtances lead me to imagine, that one accuſtomed to obſerve with attention the debris upon the ſea coaſts, &c. may without heſitation, gueſs as to the peculiar nature of the rocks themſelves, without a cloſe examination. The whole ſhore to Tory-lin, appears to be compoſed of porphyry, with ſandſtone here and there, and both penetrated with veins of baſalt, and dark green coloured pitchſtone. The hills back from the ſhore are formed of ſcenite, which is very probably penetrated with veins of baſalt, as that at the head of Glen-Cloy. From the Shiſkin to Tory-lin, there is a tolerable road, which is a rarity in this iſland, and extremely agreeable to the traveller, after having ſcrambled around the ſhore from Brodick bay. The land now becomes lower, and has more of the rural appearance of the lowlands of Scotland. Agriculture is followed with ſome ſpirit, and even many of the ſea beaches are cultivated.

Tory-Lin conſiſts of a few houſes, pleaſantly ſituated in a hollow, at a little diſtance from the ſea ſhore, and ſurrounded with ſandſtone hills. In the burn which runs paſt the houſes, I obſerved veins of baſalt penetrating the ſandſtone in different directions, and amongſt the bowlder ſtones which cover its bottom, fragments of an olive green coloured pitchſtone preſented themſelves, ſhowing the exiſtence of veins of that foſſil in the neighbourhood. Upon the ſhore a curious ſpecies of porphyry, (different from wacken-porphyry,) makes its appearance, and ſeems to be traverſed with veins of common baſalt, which are here of very great ſize. The ſhore from this to the Benin-Head, the moſt ſouthern part of the iſland, is principally compoſed of ſandſtone, penetrated with veins of baſalt, which are ſometimes of great ſize, and run in a great variety of directions. The hills back from the ſhore appear to be entirely compoſed of ſcenite and porphyry, but are not of any great height, and the whole country to the Benin-head is conſiderably cultivated, and here and there interſperſed with ſmall villages, and flocks of cattle, which give to the whole a picturesque feature, which we have ſeldom an opportunity of obſerving in this iſland. At the Benin-head, the cliffs are of conſiderable height and very precipitous. It is compoſed of a curious ſpecies of baſalt and porphyry: the baſalt is traverſed by perpendicular veins of a baſaltic rock of a different ſpecies, and has a tendency to the columnar form, which is alſo the caſe with the porphyry.

From this to Whiting Bay, the cliffs are low, formed of ſandſtone penetrated with baſalt veins, which run in a vaſt variety of ſingular directions. The hills however, up from the ſhore, now change their appearance, preſenting broad, bare, perpendicular faces, ſimilar to thoſe which occur in all baſaltic countries; and upon examination, we find them to be compoſed of various ſpecies of baſalt,* lying upon a red coloured ſandſtone, which is intermixed with grunerde, and a grey ſchiefer thon. This baſalt is often columnar, and the perpendicular crags being ſcattered in various directions, and often riſing in groupes above each other, have a pleaſing effect.* Near to Whiting bay, there are conſiderable rocks of grunſtein, of nearly the ſame kind with that found near the Cory-gills; it is not in any conſiderable quantity, and appears to be the moſt unfrequent rock in the iſland.

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* An important obſervation has been lately made upon the Continent, by Suckow, a conſiderable mineralogiſt. Upon breaking a ſpecies of baſalt which contained ſeveral cavities, he found them filled with a tranſparent colourleſs water, of which he collected two ounces, and found that one hundred grains held in ſolution two grains of ſiliceous earth.

At Whiting bay, the cliffs diſappear, until we come to the entrance of Lamlaſh bay; in their place we have an extenſive beach, bounded by gradually riſing ſandſtone hills, much penetrated with baſaltic veins. When the tide ebbs, the bottom of the bay preſents a moſt aſtoniſhing and ſurpriſing collection of baſaltic veins, which have been laid bare by the action of the ſea; here they are to be ſeen running in all directions, meeting and croſſing each other in a moſt curious manner;

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* The columns, although regularly ſix-ſided, are with great difficulty diſtinguiſhed from ſandſtone; indeed the greater part of the ſtratified baſaltic matter in this iſland, appears either to be penetrated with a ſandſtone, as the columns at Dunbar, or the ſandſtone is intermediate between baſalt and ſandſtone,

in ſhort, this is one of the moſt intereſting parts of the iſland, for obſerving the various turnings, &c. of theſe ſingular appearances. At the entrance of the famous bay of Lamlaſh, the ſandſtone forms conſiderable cliffs, which continue of ſome height, but are gradually lower as we approach the village of Lamlaſh, where there is an extenſive flat beach. Theſe cliffs are alſo traverſed with veins of baſalt, and in ſome places a few hundred yards from the ſhore, I obſerved many detached maſſes of green pitchſtone, ſhowing its exiſtence in the neighbourhood.

Lamlaſh bay, which is the beſt harbour in the iſland, and one of the beſt in the Firth of Clyde, is of a ſemi-circular ſhape, and is formed in part by Holy iſland or the iſland of Lamlaſh, which lies acroſs it, leaving two entrances, one from the north, the other from the ſouth, which laſt is always preferred by mariners. It is bounded upon the Arran ſide by hills, which in general riſe gradually from the ſea ſhore, the lower part being of ſandſtone, and the higher, as far as I examined, of ſcenite. Upon the eaſt ſide of the bay, attempts have been made to aſcertain the preſence of coal, but without effect.

Lamlaſh or Holy iſland, is about three miles long, and half a mile broad, precipitous on the eaſt, alſo conſiderably abrupt on the weſt ſide, but the north and ſouth ends are low. It is compoſed of red-coloured ſandſtone, which is in ſome places formed into ſmall caves; one is celebrated for being the reſidence of the holy diſciple of St. Columba, St. Mool-jos, or the ſervant of Jeſus. This ſandſtone is covered in many places with a ſpecies of baſalt, much reſembling that near Whiting bay, and difficultly diſtinguiſhable from ſandſtone. It forms in many places regular colums, generally ſix-ſided, which riſe range above range, giving a faint idea of the ſtupendous ſcenery of Staffa or Bo-ſhela. Upon the weſt ſide, the columns are of greater ſize than upon the eaſt, and the ſame matter appears to form the ſummit of the iſland, which is reckoned about ſeven hundred feet high. Towards the ſouth end, ſeveral veins of common baſalt make their appearance running in the ſandſtone; and, in ſeveral places, a curious ſpecies of yellow pitchſtone runs through the ſandſtone in the form of veins.

ARRAN.

CHAP. VI.

DESCRIPTION OF THE FOSSILS, OCCURRING IN THE PRECEDING CHAPTER.

PITCHSTONE, from Drumodoon.

SEVERAL ſpecies of this intereſting genus, are to be obſerved at Drumodoon. Of theſe, the following are the moſt remarkable.

1ſt Species,

Colour.—Black, with a browniſh hue, intermixed.

Luſtre.—As bright as that of ſilk, but greaſy.

Tranſparency.—None.

Fracture.—Uneven, approaching the ſplintery.

Hardneſs—Gives a few ſparks with ſteel.

Quartz, and a reddiſh matter, like garnet, is diſperſed through it.

2d Species.

Colour.—Yellowiſh green, maculated with red, and interſperſed with black ſpots.

Luſtre.—None.

Tranſparency.—None.

Fracture.—Uneven, ſplintery.

Hardneſs.—Gives a few ſparks with ſteel.

Rounded maſſes of brown coloured quartz, are diſperſed through it. It decompoſes in the form of a white tegmen or cruſt.

3d Species.

Colour.—Yellow, or greeniſh yellow.

Luſtre.—None.

Tranſparency.—None.

Fracture.—Even, ſometimes ſplintery.

Hardneſs.—Gives a few ſparks with ſteel.

Fuſibility.—A fragment from a ſix-ſided column, much reſembling this, ſoftened at 81°; at 118° a compact brown vitreous maſs was formed, which had interſperſed white grains.

By decompoſition, it acquires a brick red tegmen.

4th Species.

Colour.—Brown, with ſhades of black.

Luſtre.—Very faint.

Tranſparency.—Tranſmits light at the edges.

Fracture.—Even, with a tendency to the ſplintery.

Hardneſs.—Gives fire, pretty plentifully, with ſteel.

It has a number of white ſpots diſperſed through it, which acquire a brown colour, by decompoſition, as alſo the baſe.

5th Species.

Colour.—Browniſh, or greyiſh black.

Luſtre—Faint.—

Tranſparency.—Tranſmits light at the edges, but more ſo than the former ſpecies.

Fracture.—More or leſs fine, ſplintery.

Handneſs.—Gives fire with ſteel, more plentifully than the former ſpecies.

Quartz is diſperſed through it, in the ſame manner as in the former, and a few ſpecks of feltſpar now and then occur. It decompoſes in the form of a white cruſt, or tegmen.

Theſe different ſpecies of pitchſtone are all to be obſerved in the ſame vein, and appear to graduate, or paſs into each other, imperceptibly. In the firſt place, the green coloured, which is the moſt common, paſſes to the maculated, or 2d ſpecies, and this again into the yellow. In this ſtate it appears to be intermediate between pitchſtone and hornſtone, for Klaproth found a ſubſtance of this kind fuſible; and, Mr Kirwan mentions a greeniſh white hornſtone, from Lorraine, which appears to be ſimilar to this, and which he found to be fuſible. The yellow coloured ſpecies paſſes to the brown, or 4th ſpecies, which has much the appearance of hornſtone.

Interpoſed between the ſandſtone and pitchſtone, we obſerve a ſubſtance, which preſents the following characters:—

Colour.—Greyiſh white.

Luſtre.—A faint glimmering, from diffuſed ſhining particles.

Tranſparency. None.

Fracture.—Even, earthy, with a tendency to the ſplintery.

Hardneſs.—Gives fire, moderately, with ſteel.

This foſſil appears to be intermediate between hornſtone, and ſandſtone; ſo that we have now traced the pitchſtone, through its different intermediate ſtages, to hornſtone, and this laſt, appears to be a link of the gradation to the ſandſtone.

Porphyry, with a baſis intermediate between wacken and hornſtone, but with a greater tendency to wacken.

BASIS.

Colour.—Greyiſh.

Luſtre.—None.

Tranſparency.—A little at the edges.

Fracture.—Even, paſſing to the fine ſplintery.

Hardneſs.—Gives a few ſparks with ſteel.

It contains, immerſed in the baſis, cryſtals of common red feltſpar; and white feltſpar, approaching adularia; the cryſtals are of conſiderable ſize, and this is one of the principal diſtinctions between this ſpecies and ſome of thoſe found in Glen-Cloy. It decompoſes, in the form of a brick-red cruſt, ſimilar to ſome of the pitchſtones.

In other ſpecimens, the porphyry, as it comes in contact with the veins of baſalt, has a baſe conſiderably reſembling it; and at the columnar promontory of Drumodoon, the ſpecimens often cannot be diſtinguiſhed from what is called Trap Porphyry.

A ſubſtance intermediate between ſandſtone and wacken, having a tendency to the columnar form. Farm of Drumodoon.

Colour.—Yellowiſh.

Luſtre.—None.

Tranſparency.—None. It feels much like a ſandſtone.

Fracture.—Even, earthy, with the appearance of rounded concretions.

Hardneſs.—Gives a few ſparks with ſteel, but it contains confuſed fragments of quartz, which may have been the cauſe of this. Emits a ſtrong earthy ſmell, when breathed upon *.

Fuſibility.—Melted at 79°.

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* Lampaduix has diſcovered that hornblende contains charcoal diffuſed through it, and Mr Kirwan ſuſpects that ſome ſpecies of pitchſtone contain it. It is conjectured that it may exiſt in other foſſils, and cauſe the peculiar earthy ſmell, which we perceive by breathing upon ſtones.

APPENDIX,

CONTAINING OBSERVATIONS UPON

PEAT, KELP, AND COAL.

The following obſervations and experiments upon Peat, Kelp and Coal, may appear to ſome unconnected with the preſent work; they are ſo far connected, however, that theſe ſubſtances occur in the iſlands we have juſt been deſcribing, and are there objects of great importance. On that account it has appeared not unuſeful to relate the few experiments and obſervations which I have had an opportunity of making. They are to be conſidered, however, only as the beginning of an inveſtigation, which I hope ſoon to proſecute in a more extenſive manner.

PEAT.

THIS curious and uſeful ſubſtance has been long known as an article of fuel to the inhabitants of the North of Europe, and uſed as ſuch in thoſe regions where no coal has been found to defend the inhabitants from the rigors of a frozen climate. The learned Torfœus informs us, that its uſe was firſt made known to the inhabitants of the Orkney and Shetland iſlands, by one Einar, a Norwegian, who, from that circumſtance, was named Torf Einar. It ſoon after this came into very general uſe, and is now the only fuel of many parts, not only of the iſlands and Highlands of Scotland, but of other nations in the North.

In deſcribing the general appearance of a peat moor, we may conceive an almoſt entire flat of ſeveral miles extent, of a brown colour, here and there marked with tufts of heather, which have taken root, owing to the more complete decompoſition of the ſurface peat; no tree or ſhrub is to be ſeen; not a ſpot of graſs to relieve the eye, in wandering over this dreary ſcene. A nearer examination diſcovers a wet ſpungy ſurface, paſſable only in the drieſt ſeaſons, or when all nature is locked in froſt. The ſurface is frequently covered with a ſlimy black-coloured ſubſtance, which is the peat earth, ſo mixed with water, as to render the moſs only paſſable by leaping from one tuft of heather to another. Sometimes, however, the ſurface of peat moſſes have a different aſpect, owing to the greater abundance of heath and other vegetables, as the ſchœni, ſcirpi, eriophora, &c. but this is principally the caſe with ſome kinds of what are called Muirlands, which contain but little peat, being nearly compoſed of the interwoven fibres of the roots of living vegetables.

Many different ſpecies of peat might be deſcribed, but ſuch an inveſtigation is not ſuited to my preſent purpoſe; I ſhall therefore content myſelf with mentioning the ſubſtance in a general way. Quick moſs (as it is called) is a ſubſtance of a more or leſs brown colour, forms a kneadable compound, and when good, cuts freely and clean with the ſpade; but when it reſiſts the ſpade, by a degree of elaſticity, it is found to be leſs compact when dried, and is of an inferior quality. The beſt kinds burn with a clear bright flame, leaving light coloured aſhes; but the more indifferent kinds, in burning, often emit a diſagreeable ſmell, and leave a heavy red-coloured kind of aſhes. In digging the peat we obſerve that, when firſt taken from the pit, it almoſt immediately changes its colour, and in time becomes more or leſs of a deep brown or black colour; and the peat matter becomes much altered, being incapable of forming a kneadable paſte with water. When dry and reduced to powder, as it is often by the action of the weather, it forms a blackiſh-coloured powdery matter, capable of ſupporting vegetation, when calcareous earth is added. Peat earth is very retentive of moiſture, which circumſtance affords us a ſatisfactory explanation of the floating iſlands, obſerved in many places of Holland, as Friſe, Breme, Groningue, Oldemburg, &c. Theſe are cauſed by the peat earth or turf, retaining ſo great a proportion of water as to float immenſe maſſes of it, which are driven about upon the ſurface of lakes; or are floated upon the land itſelf. This is ſo well known in Holland, that tracts of moſs, of great extent, are ſecured by means of chains, &c.

Peat is found in very various ſituations, often in vallies or plains, where it forms very extenſive deep beds, from three to forty feet deep, as thoſe in Aberdeenſhire; it alſo occurs upon the ſides of mountains, but even there it is generally in a horizontal ſituation. The tops of mountains, upwards of two thouſand feet high, in the Highlands of Scotland, are covered with peat of an excellent kind. In Germany, it is alſo found at very great heights, thus the Blogſberg, a high mountain in Lower Saxony, and the Brohen, the higheſt mountain of the Hartz, are covered to their ſummit with peat. It is alſo found in ſituations nearly upon a level with the ſea; thus the great moſs of Cree in Galloway, lies cloſe upon the ſea, on a bed of clay, little higher than flood-mark at ſpring tides; Locker-moſs, hard by Dumfries, about ten miles in length, is only a few feet above high water mark; in the iſland of Lewis, one of the Hebrides, there is an extenſive plain, about thirty miles long, covered with peat moſs, having its ſurface very little elevated above that of the ſea. In other places, as in Holland, a kind of peat is obtained by dragging mud from the bottom of canals, and moulding it into the form of bricks; this ſpecies is alſo often taken up upon the flukes of anchors, on the coaſt of Holland, and is ſometimes caſt aſhore in ſtormy weather, which has led ſome ſpeculators to imagine that it is of marine origin. In the harbour ot Oban in Argyleſhire, one part of the bottom appears to be formed of quick moſs, which affords no ſure anchorage. The depth of the ſea is there about twenty fathoms *.

It appears to be peculiar to cold climates, which is one of the innumerable inſtances of the wiſdom of nature in providing the inhabitants of a cold country, with a material ſo neceſſary for their comfort, and even their exiſtence. Dr Anderſon, in his Treatiſe upon Peat, remarks, that it is not confined to cold climates, as he had

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* Anderſon's Treatiſe upon Peat Moſs.

had ſpecimens of real peat ſent him from the iſland of Sumatra. It is not improbable that a ſubſtance reſembling peat in ſome of its properties, may be found in the warmeſt countries, when we reflect that decayed vegetable matters, in a certain ſtage of their decompoſition, have an appearance ſo like peat, that they want only compreſſion to form a ſimilar ſubſtance. On this account, it is not ſurpriſing, that ſomething of this kind ſhould occur in the warmer regions; but it is impoſſible to conceive the exiſtence of great maſſes of matter like our peat, in the Tropical regions. This obſervation is rendered more probable from the following remarks: In Scotland, it is obſerved, that the peat, at the bottom of a mountain, is more decompoſed than at its top, and the wood of moſſes is more freſh upon the higher part of a mountain than at its lower. It is alſo remarked, that the peat of the South of England is more decompoſed than that of the North of Scotland; and the peat of France has more of the coaly appearance, than that of England. In France alſo, Mr Arthur Young remarks, * that the peat is never found in the low lands, but under

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* Travels through France.

under cover of vaſt ſize; and it is only in the higher regions, where the climate is more temperate, that it is to be obſerved upon the ſurface. All theſe facts ſhow us, in a ſatisfactory manner, that as we advance towards the warmer climate, the vegetable matter is more and more decompoſed, until we arrive at the Tropical regions, where, in all animal and vegetable matters, putrefaction proceeds ſo rapidly, as to prevent the formation of any body of this ſubſtance.

It will not be foreign to my preſent purpoſe, to mention, in a curſory manner, the moſt remarkable undecompoſed vegetable matters, which have been obſerved in our peat moſſes, or bogs; particularly as writers have endeavoured to draw concluſions, with regard to the time and mode of formation of peat, from the appearances which theſe bodies preſent.

1. Fir or Pine.—This tree more frequently occurs, than any other; it is found of various ſizes, ſome having been dug about one hundred feet long, perfectly ſtrait, with branches growing in a circular form; as is the caſe with the pine

tribe. It is remarkable, that in ſuch ſituations the wood has often loſt its latitudinal adheſion, which renders it ſoft; but that the longitudinal fibres are ſtrong, and tough, ſo that they are ſplit, and twiſted, to form halters for cattle, as in Aberdeenſhire.

2. Oak.—In all the low moſſes, in Scotland, this tree is the principal one which is to be obſerved, and is generally found wanting the bark, which ſhews that the wood had been long dead before it had been enveloped in the moſs. In draining Hartfell level, in Yorkſhire, oak trees were found, not leſs than 100 feet long. They were black as ebony, in excellent preſervation, and ſome of them ſold, in the middle of the laſt century, for 15l. a tree. One of them, which is particularly deſcribed, was about one hundred and twenty feet long, twelve in diameter, at one end, and ſix at the other; and 20l. was offered for it. Dr Anderſon remarks, that he never ſaw a piece of oak taken from a peat moſs, which could be uſed in workmanſhip, like the ſtakes which were lately taken from the Thames, and ſaid to have been placed there by Julius

Cæſar; from this he concludes that moſs does not preſerve wood, ſo long as water. This, however, is contradicted from the facts obſerved at Hartfell level.

3, Birch.—This tree alſo frequently occurs in our peat moſſes, but its wood is not ſo reſinous as that of the fir, nor has it the hardneſs of the oak; on theſe accounts it is ſeldom found in a ſtate of good preſervation; the bark is generally the moſt entire, which may depend upon the great quantity of reſin which it contains, which enables it to reſiſt the all powerful hand of time.

The alder, yew, willow, aſh, and ſeveral other trees, have been dug out of our moſſes, but any detailed account of theſe would lead me to a great deal of unneceſſary deſcription: I may here mention, however, that, beſides trunks and branches of trees, we alſo ſometimes diſcover their more delicate parts in a ſtate of preſervation; thus the leaves have been obſerved well preſerved. Seeds, which have a remarkable power in reſiſting the influence of the weather, have been found in peat moſſes; thus we have inſtances of fir cones and hazel nuts; the kernel of this laſt was deſtroyed, and the ſhell, which is very indeſtructible, was freſh.

Beſides trees and herbaceous plants, another tribe deſerve to be particularly noticed, which are the muſci. Theſe plants are fond of moiſture, and, with a ſufficiency of room to ſpread upon, and a cold climate, grow very faſt and luxuriantly. Of theſe the moſt remarkable is the ſphagnum paluſtre of Linnæus, which is found in great abundance in all peat diſtricts, particularly in thoſe places where the ſoft white peat abounds; this peat is found ſeveral feet deep, and is nothing but a collection of the ſphagnum, which we can obſerve more or leſs decompoſed as we go downwards; at laſt its texture diſappears, its colour changes, and it cannot be diſtinguiſhed from the common brown peat.

A curious ſubſtance has been found in the peat moſſes of this country, which requires a particular deſcription.

Colour, white; has nearly the reſemblance of tallow, feels greaſy, and ſtains paper as tallow does; flames with much ſmoke, leaving a pretty light coaly matter. It is brittle like tallow, but its ſpecific gravity is conſiderably leſs.

A ſubſtance ſimilar to this was found ſome years ago by peaſants on the coaſt of Finland, and afterwards in one of the Swediſh Lakes, and lately at Straſburgh. It appears to be the ſubſtance deſcribed by Mr Kirwan, under the name of Mineral Tallow.—Humbold, in a letter to Van Mons in the Annales deChymie, vol XXII. p. 64. mentions, that he had converted the Phallus eſculentus into a ſubſtance reſembling tallow, by means of the ſulphureous acid, and had alſo made ſoap of it. I endeavoured to repeat this with the Agaricus horizontalis, by means of the nitrous acid, but without ſucceſs. May not the mineral tallow of peat moſſes be a ſpecies of fungus, altered by ſome natural operation ſimilar to what we have here mentioned?

A great number of extraneous ſubſtances have alſo been found in peat moſſes, ſometimes at conſiderable depths, from their appearance, declaring, in certain characters, the great antiquity of ſuch moſſes. Many curious inſtances of this kind might be mentioned; one in particular deſerves to be noticed. In digging a moſs at Axholm, in Lincolnſhire, the body of a woman was found pretty freſh, her hair was unaltered, her nails were rounded, and her ſkin was tanned, ſoft and pliable; ſhe had antique ſandals upon her feet, which renders it probable that ſhe was of the Roman æra. Another curious inſtance occurred in Shetland; in digging a peat moſs, the body of a man was found well preſerved, which, it was ſuppoſed, could not have been in the moſs, leſs than eighty years. In the Iriſh moſſes the horns of the mooſe deer have been found; in our own, the head and horns of the urus occur. Dr Walker has in his poſſeſſion a drawing of the head and horns of a deer, found in a peat moſs, of a ſpecies now no longer found in Britain. Other ſubſtances occur in moſſes; thus, fragments of very ancient dreſs, and many inſtruments of human induſtry have, at different times, been diſcovered.

ANALYSIS

OF THE PEAT OF GLEN-CLOY,

ISLAND OF ARRAN.

Character.—Is of a blackiſh brown colour, pretty much intermixed with undecompoſed vegetable matter, which renders it rather looſe in its texture.

SOLUTION IN WATER [*].

1. I took one thouſand grains of powdered peat, boiled repeatedly with diſtilled water, until no

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[*] Lord Dundonald remarks [†] that "the ſulphuric acid, when concentrated, acts in a ſimilar manner to that of alkaline ſubſtances, in the reſolution or deſtruction of animal and vegetable ſubſtances, diſengaging from them certain gaſſes, and forming therewith certain ſaponaceous and ſaline compounds. Theſe ſolutions or extracts are of a reddiſh brown colour, ſimilar to that produced by the action of alkaline ſalts on oxygenated peat. On the principles already ſtated, the vitriolic acid may be uſed beneficially to decompoſe, and bring into action the inſoluble matter accumulated in ſoils

[†] A Treatiſe of the connection of Agriculture with Chemiſtry, 4to. by the Earl of Dundonald.

more could be diſſolved, then dried, weighed, and found eight hundred grains remaining.

The

ſoils, by the combination of the phoſphoric and ſoreline acids, with calcareous matter." The action of the ſulphuric acid upon vegetable ſubſtances engaged my attention three years ago, and in a paper read to the Royal Medical Society of Edinburgh, I endeavoured to ſhew (what has been ſince done more ſatisfactorily by Vauquelin and Fourcroy) that acetous acid is formed; that a portion of carbonaceous matter, deprived of hydrogen, remains in ſolution, and that carbon is ſeparated. It is certain that alkalies exert no ſuch influence upon vegetable ſubſtances; in the preſent inſtance, they only diſſolve a portion of brown dehydrogenated matter, without cauſing any alteration in the proportion of the conſtituent parts. Their action upon animal ſubſtances, however, is more nearly allied: Vauquelin found, that ammonia was formed by the action of this acid; and I have reaſon for ſuſpecting that a ſimilar change is produced by the agency of potaſh or ſoda upon the muſcular fibre. A ſeries of experiments, which my father was lately engaged in, at the deſire of the Honourable board of Truſtees, led me to make this obſervation. We found that the muſcular fibre of fiſh, formed a brown-coloured ſolution, by treating it with the cauſtic potaſh or ſoda: during the ſolution, a ſmall quantity of ammonia was formed, but in far greater proportion, when tallow is added and the boiling continued. During this extrication of ammonia, a blackiſh-coloured matter falls to the bottom, which is not acted upon by alkalies; in ſhort, it appears to be the carbonaceous matter of the muſcular fibre. This change appears to be a nearly complete decompoſition of the muſcular fibre, its hydrogen and azote forming the ammonia, whilſt the carbonaceous matter is left behind, forming the inſoluble matter.

The ſolution had a deep brown colour, with a ſlightly bitter taſte; tinged litmus paper red; and, by expoſure to the air for ſome time, part was precipitated in an inſoluble ſtate.

2. By paſſing the oxygenated muriatic acid thro' this ſolution, a precipitation of a dark browniſh matter immediately takes place, ſimilar to what we obſerve by paſſing this acid thro' other vegetable infuſions.

3. Cauſtic ammonia, or carbonat of potaſh, did not cauſe any precipitation in the ſpace of twelve hours.

4. Pruſſian alkali did not afford any traces of the combinations of iron, copper, or zinc.

5. Lime water formed a copious brown-coloured precipitate.

6. Muriat of barytes, nitrat of ſilver, ſulphat of iron, ſulphat of copper, cauſed conſiderable precipitations, but nitrat of ammonia, muriat of

ſoda, muriat of ammonia, did not produce any change.

The ſolution being evaporated, left a blackiſh brown-coloured reſiduum, which had no peculiar ſmell; nor, had it any appearance of an oil, as Dr Hutton conceives it to be *. It preſents the following characters.—

a. Not ſoluble in ſpirit of wine, except by a boiling heat.
b. Diffiultly ſoluble in water, without the aſſiſtance of heat.
c. Soluble in cauſtic ſoda, at the common temperature, or when heated.
d. Soluble in cauſtic ammonia in the ſame manner.

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7. A quantity of the reſidue being put into a retort, connected with a pneumatic apparatus, a gradually increaſing heat was applied, when the following appearances were obſerved. At firſt water paſſed over quite colourleſs; after ſome time it was tinged brown, and towards the end of the operation, when no more brown liquor

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* Hutton's Theory of the Earth, Vol. I. page 578—9.

quor came over, carbonic acid, and carbonated hydrogen paſſed in conſiderable quantity: no oil or ſaline matter could be detected, and not the leaſt traces of ammonia could be perceived. The carbonaceous reſidue was of a blackiſh brown colour, inſoluble either in hot or cold water, but eaſily ſoluble in a weak ſolution of cauſtic ſoda.

The eaſe with which this carbonaceous matter is diſolved in weak ſolutions of alkali, ſhows that it contains a conſiderable portion of hydrogen, (at leaſt this is the explanation given by modern chemiſtry); for I find it impoſſible to diſſolve any perceptible quantity of charcoal with ſuch ſolutions.

8. The reſidue, by burning, affords a grey coloured aſh; which I examined, in order to aſcertain the nature of the ſaline matters. It did not afford ſulphur of potaſh or ſoda, phoſphat of lime, or poſphat of iron; only *ſulphat of magneſia, and oxyd of iron.*

To the eight hundred grains, which I found inſoluble in water, I added a ſolution of cauſtic ſoda, which acquired a brown tinge at the common temperature; but when heated, a very deep brown-coloured ſolution was formed: after repeated digeſtion with the alkali, I was able to diſſolve four hundred grains; the remainder was undecompoſed vegetable matter, which was quite inſoluble in the alkali I uſed.

I next added muriatic acid to this alkaline ſolution, after which the diſſolved matter was precipitated of a brown colour, and did not appear to be altered by its combination; for it was ſtill ſoluble in cauſtic ſoda, and ammonia, inſoluble in water by boiling, but ſoluble in ſpirit of wine. When burnt, a brown-coloured aſh is left, which afforded ſulphat of lime and oxyd of iron, but in no inſtance did I find phoſphat of iron or phoſphat of lime.

PROPERTIES OF THE ACID CONTAINED IN PEAT.

In relating the characters of the aqueous ſolution, I obſerved that it tinged litmus paper red.

This ſhows the preſence of an acid, which I found to poſſeſs the following characters.—

1. It is not cryſtallizable, but may be obtained by evaporation, in the form of thin cruſts.

2. Taſte, ſlightly acid.

3. Forms compounds with lime, barytes and ſoda, which I have not particularly examined. The compound of lime and this acid is difficultly ſoluble in water, which diſtinguiſhes it on the one hand from the gallic acid, as it forms a very ſoluble compound with lime; on the other, from the oxalic, which forms an inſoluble ſalt with lime[*].

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[*] Lord Dundonald affirms, that peat contains the oxalic and phoſphoric acids, which, according to his explanation, are of great uſe in ſeveral of the operations of nature; thus, when lime is added to peat, it is imagined that an oxalat of lime is formed, which, by the addition of ſulphuric acid is decompoſed, and a gypſum formed, while the oxalic acid enters into new combinations, uſeful in promoting the growth of plants. We have already ſhown, however, that this acid is very different from the oxalic; but allowing it to be the ſame, it is contrary to well known chemical affinity to ſuppoſe that the ſulphuric acid can decompoſe the oxalat of lime.— In the experiments I have made, none of the combinations of phoſphoric acid appeared.

4. Decompoſes the acetite and nitrat of lead.

5. With ſulphat of copper, a copious brown-coloured precipitate is formed, having a beautiful green ſupernatant liquor.

6. With ſulphat of iron, it forms a brown precipitate, and a nearly colourleſs ſupernatant liquor.

8. Nitrat of copper changes the ſolution to a beautiful green, without cauſing any precipitation. In this it alſo differs from the oxalic acid, which cauſes a copious precipitation.

9. Muriat, and nitrat of barytes are decompoſed by it.

10. With ſolution of ſulphat of indigo, it forms a beautiful green colour; in this it alſo differs from the oxalic acid, which does not produce any change of colour.

This acid appears to be the ſame with the ſuberique acid, lately diſcovered by Buillon La Grange, and which he imagines to be a compound of carbon, hydrogen and oxygen: Several facts, which I have remarked in a ſeries of experiments concerning the action of the nitrous acid upon charcoal, lead me at preſent to ſuppoſe it to be a compound of carbon and oxygen. On that account I ſhall now give a ſhort detail of the moſt intereſting phenomena that occurred in theſe experiments.

I found, by the action of nitrous acid upon charcoal, that a brown, bitter, ſomewhat deliqueſcent maſs was formed, which was ſoluble in water, ſpirit of wine, and alkalies, and emitted a moſt fragrant aromatic odour, particularly when heated. This matter could be rendered more or leſs ſoluble in water, according to the length of time it was expoſed to the action of the acid; but if the acid was ſtrong, and in conſiderable quantity, a conſiderable proportion of the charcoal was converted into an acid, which preſented the following character of the acid from charcoal:

1. Tinges litmus paper red.

2. Is not cryſtallizable; forms only thin tranſparent cruſts by evaporation

3. Forms compounds with barytes, potaſh, ſoda, lime and ammonia; and the following is their order of affinity for the acid:—

Barytes,
Potaſh,
Soda,
Lime,
Ammonia.

4. It decompoſes the nitrat and muriat of barytes.

5. When combined with lime, the compound is decompoſed by the oxalic acid, which ſhows a very decided difference between this acid and the oxalic.

6. With ſolution of ſulphat of indigo, it forms a beautiful green colour.

7. With ſolution of ſulphat of zinc, a ſlight precipitation was produced.

8. With ſulphat of iron, ſulphat of copper, nitrat

trat of lead, and nitrat of copper, the ſame appearances were produced as with the acid from peat.

The properties of this acid are ſimilar to that of the ſuberique ; of courſe to the acid of peat ; if then we can render it probable, that any one of them is compoſed of carbon and oxygen, it follows that the others are to be viewed as the ſame.

Charcoal is now allowed to be the carbonaceous baſis, deprived of hydrogen, and when all earthy and ſaline matters are ſeparated, we have it in the pureſt ſtate poſſible, when it is called Carbon *.

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* The ingenious Dr Bancroft, in his book upon Dying, conjectures, that charcoal is a vegetable oxyd ; that is, the carbonaceous baſis, combined with a ſmall portion of oxygen. The principal objection to the common opinion, is the great indeſtructibility, and the black colour of charcoal ; for, ſays he, " if this did not depend on an abſorption of oxygen, and did it really exiſt with its black colour, naturally in vegetables, why do not we find it remaining entire, after the other parts of vegetables are ſeparated or deſtroyed by fermentation and putrefaction ? and why does it diſſolve and rot with them undiſtinguiſhed, and contrary to what happens when it exiſts ſeparately in the form of charcoal; and why, in this form, will it not recombine with

" matter,

gin and formation of peat; opinions, as is uſual on ſuch occaſions, very various, and often whimſical. One claſs of obſervers have contented themſelves by endeavouring to ſhow that it is of vegetable origin, and have only differed as to the probability of wood, or moſs alone, or jointly, having formed it; other obſervers again, having admitted its vegetable origin, differ only in the explanation of the means which nature uſes in the preſervation of the vegetable remains. Laſtly, it has been conjectured, that it is a *live vegetable, ſui generis*; and an elegant poet having admitted its vegetable origin, has ſuppoſed ſome changes it undergoes by elutriation, &c.

There can be no queſtion of the vegetable origin of this ſubſtance: any other opinion is but vain and frivolous: and, it is alſo inconſiſtent with fact, to aſſert, that either wood or moſs ſingly are the only ſubſtances that form peat; for we know that in moſt caſes they both contribute to its formation. In conſidering the peculiar ſtate of preſervation of the vegetable matter in peat, it is very generally believed that fallen wood, when it begins to putrify, produces an extract of the nature of tan, which preſerves the moſs that grows up among the trees, and converts it into peat. This opinion is founded upon the known action of aſtringent ſubſtances in preſerving animal nature from decay; it will therefore be neceſſary to examine this proceſs, to diſcover if it will help us to explain the phenomena of peat. It is but lately that we have had any probable explanation of the tanning proceſs; and we are indebted to an excellent chemiſt, Seguin, for ſome intereſting experiments and obſervations upon this ſubject *. He informs us, that oak bark, &c. contains two ſubſtances, the tanning principle, which has a great affinity for gluten, and the gallic acid, which has a powerful attraction for oxygen. When a ſolution of bark is applied to ſkins, he ſuppoſes that the gallic acid abſtracts oxygen from it, by which it is reduced to the ſtate of gluten, which immediately combines with the tanning principle, forming a compound, which is the cauſe of the indeſtructibility of leather. We have already ſhown that peat does not contain the gallic acid; but allowing that it does, it is impoſſible to conceive ſuch an action to take place with regard to vegetable matters, particularly

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* Journal of the Polytechnic School of France.

ly in peat, which I have found from experiment to contain no tanning principle. It will therefore be neceſſary to inveſtigate the influence of vegetable acids, &c. upon vegetable matters, before any probable opinion of this kind can be formed.

The ſingularity of the appearance which peat preſents, has led Dr Anderſon to conclude, that it is a *live vegetable, ſui generis*. This he imagines to be very ſatisfactorily proved, from the ſuppoſed impoſſibility of decaying vegetables poſſeſſing properties ſimilar to peat. He remarks, "That in vegetables, which have once fallen into a ſtate of "putreſcency, their inflammability decreaſes in "proportion as that putreſcency augments; and "that their chemical qualities ſuffer an alteration "proportioned to the ſame circumſtance. But "by the hypotheſis of every perſon who ſuppoſes "that ſphagnum is the original conſtituent matter "of moſs, it is always underſtood that the ſoggy "peat, by their hypotheſis, is the ſphagnum ſtill ſo "little decayed, as not yet to have become perfect "moſs; and that in proceſs of time, it gradually "becomes more and more perfect moſs, as it gradually becomes more thoroughly putrid, till at

" laſt, it loſes even the appearance of ſphagnum,
" and becomes hard, and perfect peat; that is to
" ſay, in other words, as it becomes more putrid,
" it becomes more inflammable, which is directly
" the reverſe of the well known progreſs of na-
" ture in every other caſe." It is upon this and ſome ſimilar arguments, that the Doctor rejects the opinion of moſs being a collection of decaying vegetable matters. But to theſe we may ſhortly anſwer, that decaying vegetables only loſe their power of burning, with the deſtruction of their carbonaceous matter; but this we know requires a very long ſeries of years, and when the vegetable matters are in a moiſt ſituation, as is the caſe with peat, ſuch a decompoſition may be prevented for hundreds of years.

The laſt theoretical opinion with regard to peat, which I ſhall mention, is contained in a note of Dr Darwin's beautiful poem, the Botanic Garden. He there gives us a truly ſtrange account of the changes which peat moſs undergoes by elutriation, fermentation, and the conſequent heat. As this is little leſs than a *dream*, it might be paſſed over; but it is detailed in the form of matter of fact, and there-
fore

fore requires to be noticed. He remarks, " That moraſſes, in great length of time, undergo a variety of changes; firſt by elutriation, and afterwards by fermentation, and the conſequent heat. By water perpetually oozing through them, the moſt ſoluble parts are waſhed away, as the eſſential ſalts; theſe, together with the ſalts from animal recrements, are carried down the rivers into the ſea, where all of them ſeem to decompoſe each other, except the marine ſalt. Hence the aſhes of peat contain no alkali; and are not uſed in the countries where peat is uſed as the fuel of the lower orders, for the purpoſe of waſhing linen. The ſecond thing which is always ſeen oozing from moraſſes, is iron in ſolution, which produces chalybeate ſprings, from whence depoſitions of ochre and variety of iron ores. The third elutriation ſeems to conſiſt of vegetable acid, which, by means unknown, is converted into all the other acids. 1ſt. Into marine and nitrous acids; 2d. into vitriolic acid, which is found in ſome moraſſes ſo plentifully, as to preſerve the bodies of animals from putrefaction, which have been buried in them; and this acid, carried away by rains and dews, and meeting with calcareous earth, produces gypſum or alabaſter, with clay it produces alum, and, deprived of its vital air, produces ſulphur. 3d. Fluor acid, which being waſhed away, and meeting with calcareous earth, produces fluor or cubic ſpar. 4th. The ſiliceous acid, which ſeems to have been diſſeminated in great quantity, either by ſolution in water, or by ſolution in air, and appears to have produced the ſand in the ſea, uniting with calcareous earth previouſly diſſolved in that element, from which have been afterwards formed ſome of the gritſtone rocks, by means of a ſiliceous or calcareous cement. By its union with calcareous earth in the moraſs, other ſtrata of ſiliceous ſand have been produced; and by the mixture of this earth with clay and lime aroſe the beds of marl." After this follow ſome whimſical notions about the formation of coal, which are connected with ſome ſuppoſed change produced by fermentation and heat. We ſhall now, in as few words as poſſible, examine the truth of the ſuppoſed change by elutriation, which is all that intereſts us at preſent. As to the firſt poſition, that the ſalts are carried to the ſea and decompoſe each other, we have no manner of probability, far leſs proof. The third ſtage of elutriation, where a vegetable acid makes its appearance, ſhould have been confirmed by experiment; its ſuppoſed converſion into marine and nitrous acids is perfectly chimerical. The exiſtence of the uncombined ſulphuric or vitriolic acid in peat, or in any other matter, is perfectly ideal *: Allowing its preſence, what kind of preſervation would it induce? it would be that of *decompoſition:* for we well know its powerful and ſpeedy action upon all animal and vegetable matters. The exiſtence of the fluor acid in moraſſes, and the ſpeculations about the ſiliceous acid, are all conjectures as odd and improbable as could be contrived.

Having now mentioned the principal characters with regard to the formation of peat, and having ſtated

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[*] "The common vitriolic acid, I believe, has never been found in nature, free from all combination, though it may unite with ſome bodies beyond the point of ſaturation. It is true, Mr Baltaſſari ſays, he found ſome dry concentrated vitriolic acid adhering to ſelenite, in a grotto in Monte Zaccolina, near Sienna; but this has been fully diſproved by the ſubſequent obſervations of Mr Murray, in the 7th volume of the Memoirs of Stockholm, and of Mr Dolomieu, in his Notes upon Bergmann de Prod.Volcan. page 88." KIRWAN'S MINERALOGY. VOL. II. P 2.

ſtated ſuch objections as occurred to me, I will now endeavour to aſcertain, upon chemical principles, the peculiar ſtate of the vegetable matter when in the form of peat. In viewing the various phenomena of decaying vegetables, two diſtinct ſtages may be uſually obſerved, the acetous, and putrefactive fermentations. Theſe proceſſes are much modified by circumſtances, depending upon the degree of heat, moiſture, the preſence of air, and the greater or longer continuance of the action of theſe agents. The putrefactive fermentation is the one which here claims our chief notice, for attention to the appearances it preſents will enable us to judge beſt of the ſtate of the vegetable matter in peat.

In the putrefactive proceſs, if the heat be conſiderable, the deſtruction of the vegetable matter is ſoon accompliſhed; the whole is diſſipated in the form of carbonic acid, carbonated hydrogen, and ſometimes ammonia; a ſmall portion of charcoal and aſhes being left behind,* a more mode-

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* It is plain, that, in general, wherever carbonic acid and carbonated hydrogen gaſſes are formed, both earthy and ſaline matters will

rate degree of heat, with moiſture, allows the matters to decompoſe more ſlowly, and to preſent the vegetable matter in ſeveral other intermediate ſtages, ſuch as we obſerve with regard to peat when more or leſs decompoſed. A very great proportion of moiſture has a powerful influence in retarding this proceſs; thus the trees which are found at the bottom of moſſes, are freſher than thoſe at the top, owing to the bottom containing a greater quantity of water; and the ſtakes, lately taken out of the Thames, is another remarkable inſtance of this.

From theſe circumſtances it is plain, that peat is a vegetable ſubſtance, which has undergone in part, and is ſtill undergoing the changes which have

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will be left behind; for carbon, which enters into the compoſition of theſe gaſſes, contains neither earthy nor ſaline matters. This being admitted, we can account for the preſence of ſaline matters in plants, without any great ſtretch of hypotheſis. It has been lately diſcovered by Lampadius, Profeſſor of Chemiſtry at Friburgh, that charcoal decompoſes water at the common temperature; and as all ſoils contain carbonaceous matter, it is plain, that during the formation of theſe gaſſes by the action of the ſun's rays, a quantity of ſaline matter will be left in the ſoil for the uſe of vegetables.

have been juſt mentioned; and many facts lead me to conclude, that the common peat or quick moſs, is the vegetable matter, deprived of a conſiderable portion of its *hydrogen.* Not only the circumſtances attending the ſituation and appearance of peat, but alſo other facts render this opinion probable.

1. Sulphuric acid being added ſlowly to oils, and triturated, they gradually become brown, when the oil is rendered ſoluble in water and ſpirit of wine; but if the acid be added in too great quantity, a black inſoluble matter is formed.

2. If oleum animale be expoſed to the action of oxygenous gaſs, water is formed, and carbon precipitated.

In this laſt experiment, we perceive, that the ſeparation of hydrogen cauſes the precipitation of carbon; in the ſame way, in the experiment with ſulphuric acid and oil, we obſerve, that in proportion as the hydrogen is diſſipated, the carbonaceous baſis becomes more or leſs ſoluble in water; and when the whole of the hydrogen diſappears, a true carbon is left behind. In the ſame manner, with regard to peat, the woody, or other vegetable matters, are ſlowly deprived of a portion of their hydrogen, become brown and ſomewhat ſoluble in water and ſpirit of wine. By a further decompoſition, more hydrogen is ſeparated; when the vegetable matter becomes inſoluble in water, but ſtill ſoluble in alkali; laſtly, nearly the whole of the hydrogen is ſeparated, when a black ſubſtance is left, what is called Peat Earth. This laſt, by long expoſure to the air, combines with a portion of oxygen, forming ſuberique acid, and appears to be what Lord Dundonald calls Oxygenated Peat.

If this explanation be thought to have probability in its favour, we may explain ſome other facts in a pretty ſatisfactory manner. Thus the great Capt. Cook remarks, that the coaſt of Tierra del Fuego, is covered with peat-moſs,and the water which runs from it has a brown turbid appearance. At one time he was obliged to water upon this dreary ſpot, and could obtain no other water but that from the peat-moſs, which made him very ſuſpicious of its qualities, ſo that at firſt it was but ſparingly uſed. Having ſoon got into the warmer regions of the

Pacific Ocean, he found that this water depoſited a ſmall ſediment, became pellucid, and was the moſt wholeſome and freeſt from putrefaction of any he had on board. It is probable that the infuſion of peat acted, in this caſe, in a ſimilar manner with charcoal (from which it differs but little) by abſtracting the putreſcent matter. Another curious fact is mentioned by Dr. Plott; that intermittent fevers never occur in the neighbourhood of peat-moſſes. This appears to be owing either to the ſlower decompoſition of the organized matter in peat-moſſes than in fens, by which a ſmaller portion of noxious gaſs is formed; or to the abſorption of theſe gaſſes by the peat matter approaching to the ſtate of charcoal. This laſt explanation is rendered the more probable from a well known fact, that in church-yards, where a great number of dead bodies are buried, no bad ſmell is to be perceived, evidently owing to the abſorption of the noxious gaſſes, by the carbonaceous matter of the ſoil.

Improvement of Moss Land.—The method of improving peat moſs, by means of calcareous earth, is certainly one of the moſt uſeful diſcoveries of the preſent day, and will, no doubt, form an important æra in the annals of agriculture. Not long ſince peat lands were only conſidered as uſeful, on account of the fuel which they afforded: the caſe is now widely altered; the moſs grounds are eagerly ſought after, and in the weſt of Scotland, this mode of improvement is carried on with great ſpirit, and is repaying the judicious manager very amply*. To give a detailed account of the methods which are followed (and that is the only one that can properly be given) would require a volume, and after all, would be little more than a repetition of what is already known. I ſhall therefore content myſelf with endeavouring to apply the preceeding experiments, to explain the mode of action of the calcareous earth. We have already obſerved that peat contains the ſuberique acid, or one nearly allied to it, which appears to be formed in greater quantity the longer the peat is expoſed to the action of the air; thus aſſiſting in retarding the decompoſition of the peat, of courſe preventing its being uſeful in vegetation. Marle, ſhells, and limeſtone, are uſeful, in a triple capacity: in the firſt place, by removing the acid, the vegetable matter is allowed to decompoſe more rapidly; ſecondly, the combination of this acid with the lime, forms a compound, which may aſſiſt in vegetation; and laſtly, this acid having a ſtronger attraction for lime than the carbonic, will diſengage it in conſiderable quantity, when it will aſſiſt vegetation. I ſhall conclude, with remarking, that there is a conſiderable prejudice in favour of quicklime; if the explanation now given have any plauſibility, it is plain that carbonat will anſwer as well, if not better, in the improvement of moſs lands.

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* The Highland Society of Scotland, with their accuſtomed liberality and deſire for improvement, have offered a piece of plate of twenty guineas, for the moſt approved eſſay, on the following ſubject. " An account of the beſt and eaſieſt method, of converting the various kinds of peat or peat moſs, into a manure, either by reducing them to aſhes, or by making them undergo the putrid fermentation. Alſo a medal, value five guineas, for the beſt Eſſay on the moſt proper method of cutting peats, ſo as to prevent the abuſe of moſſes; and alſo the particular ſeaſons of the year when the moſſes ought to be flooded, to encourage their growth and renewal."

KELP.

THIS uſeful material does not appear to have been known as a manufacture in Britain, until ſome time after the beginning of the preſent century; owing to the backward ſtate of the ſoap and glaſs manufactures, which, particularly in Scotland, have not been carried on with ſpirit above thirty years. It will not then ſurpriſe us, when we learn, that its firſt introduction was about the year 1730 into the iſland of Uiſt, by a Highland gentleman, of the name of M'Leod, who brought it from Ireland, where it had been carried on for many years before. The method he followed was, in all probability, a bad one, as he was ſatisfied by merely reducing the ſeaware to aſhes; but this was ſoon given up, and the plan of fuſion, which is now followed, was adopted. This manufacture ſoon found its way into all the other iſlands, for we find it forming an article of trade in Shetland, ſoon after its firſt introduction into the Hebrides. The quantity of kelp, at firſt made, was trifling; but the great increaſe and the rapid progreſs of the manufactures depending on it, ſoon raiſed the price and increaſed the quantity; the following being, as far as I can collect, pretty nearly the average price of kelp from the year 1740, to the preſent time.

From 1740 to 1760	average price about	L.2 5s. a ton.
1760 to 1770	- -	4 4s. a ton.
1770 to 1780	- -	5 0s. a ton.
1780 to 1790	- -	6 0s. a ton.

Since the year 1791, its value has greatly increaſed, and has now riſen to a greater height than was ever known before, owing to the war, which has prevented the importation of the uſual quantity of barilla, and has thus raiſed kelp to the enormous price of L.11 0 0 a ton. In Shetland from 250 to 300 tons are made annually, but this quantity bears ſo ſmall a proportion to the extent of the lands as not to have affected the rent in an equal degree to that of Orkney, where, within theſe ſeven years paſt, ſmall farms about L.40 rent, have riſen to L.300 a year.

In Shetland, the coſt of manufacturing is from L.2 to L.2 10s. 0 a ton; but, in the weſt Highlands, the price of labour is greatly lower, being from L.1 to L.1 10s. a ton; from this we may eaſily perceive the immenſe profits. The method of manufacturing is ſufficiently ſimple. The different ſpecies of fuci, particularly the veſiculoſus and ſerratus, are cut from the rocks in the months of May, June, and July, and ſpread out and dried ſo as to enable them to burn more eaſily. In drying the ware they are very cautious to prevent any fermentation from taking place; for it is found, that ware thus changed, does not afford ſo good a kelp as when well dried. This curious circumſtance is well deſerving the attention of the chemical philoſopher, as a proper inveſtigation may lead to ſome curious facts with regard to the decompoſition of the muriat of ſoda, and the nature of alkalies. Mr Headric, in a report upon the ſubject of manures, to the Board of Agriculture, remarks, "That a perſon verſed in chemiſtry, informed him, that ſea plants when bruiſed "and macerated with water in their freſh ſtate, "yield no ſaline ingredient, excepting ſea ſalt or "muriat of ſoda. That when burnt, they yield

" vegetable alkali, or potaſh, but no ſoda." Whatever truth be in theſe experiments, they certainly deſerve to be repeated, particularly as they are rendered ſomewhat probable from an obſervation made by intelligent ſoap manufacturers. They remark, that all kelp made from rotted ware, as is frequently the caſe upon the coaſt of Norway, *works ſoft*, that is, in the manner of potaſh, forming a ſoap which becomes ſoft, if expoſed, for ſome time to the air. The ware being ſufficiently dried, a pit is dug upon the ſhore (generally in the ſand) ſeven feet wide, and three or four feet deep, and is lined with ſtones. A fire is now kindled in the bottom, and the dried fucus is laid upon it by degrees; they keep adding freſh quantities until the pit is nearly filled, when the whole is frequently ſtirred; towards the evening the whole gets into a ſemifluid ſtate; it is then allowed to cool and is afterwards taken out of the pit ready for the market. In this method of burning, a conſiderable portion of ſand and earthy fragments, is unavoidably mixed with the fuſed maſs, beſides what is added intentionally by the burners to increaſe its weight, and, as they imagine, its value. This notion is very falſe, as kelp of this kind is eaſily detected by a ſkilful merchant; who, of courſe, reduces its price, and a kelp, which, if honeſtly prepared, might have brought a good price, is now reduced on this account, one third of its value. Another very material cauſe of the badneſs of kelp, is the fuſion of the alkali with the ſiliceous matter, forming a compound, ſaid to be of no uſe in ſoap making; as, in this way, a conſiderable portion of alkali is deſtroyed.

Theſe obſervations, which muſt occur to every one, upon a little reflection, engaged the attention of my father ſome years ago, who endeavoured, by a ſeries of experiments, to aſcertain whether it would be of advantage to burn the wrack in furnaces, where it would not be liable to be mixed with ſiliceous earth, &c. as, in this way, he imagined he would increaſe the proportion of alkali, with very little additional expence. Accordingly he erected ſeveral furnaces upon different plans, in which the ware was burnt, and the kelps afterwards examined; but a recapitulation of theſe extenſive experiments would be inconſiſtent with the intended ed brevity of this publication; I ſhall, therefore, only mention what he conceived to be the beſt form of a furnace. It conſiſts of one fire place, covered with an arch, which communicates with four reverberating cavities, into which the ware is thrown. This fire place, with a ſmall quantity of fuel, produced a kelp of greater ſtrength than any he had examined during his long practice; and, upon calculation, it was found that the expence of furnaces and fuel was greatly more than repaid by the increaſed value of the kelp.

The growing of fuci upon ſhores, is now become an object of ſome conſequence, not only from their value, as affording kelp, but alſo on account of their great and ſucceſsful uſe as a manure. It has, therefore, been recommended to roll ſtones upon the ſhores, which, in many places, can be done at ſmall expence, and theſe in two years, become covered with fuci, in ſuch quantity as to be cut. Calcareous ſtones are found to anſwer beſt, by far. It is alſo worthy of remark that a greater quantity of ware is to be got at the bottom of a bay, than at its ſides, where the ware is more expoſed to the violent action of the tides and waves.

Merchants, in their examination of kelps, are poſſeſſed of a few rules, which they generally follow, in determining their relative value; the chief of theſe are, taſte, ſmell, colour, compactneſs, and general appearance. That theſe will enable us to gueſs vaguely at their value, cannot be denied, but any thing like certainty is not to be expected. A perſon, no doubt, who has been in the long habit of uſing theſe characters, will, after ſad experience, be more expert at this gueſſing than another. It requires no foreſight to perceive, that truſting to external characters, in ſo heterogeneous a maſs as kelp, muſt often lead the unwary buyer into a diſagreeable predicament, in purchaſing as good, what upon actual trial he finds of comparatively little value. Theſe remarks are not idle conjectures; nor are they thrown out to ſhow the utility of a chemical acquaintance with the ſubſtance; but founded on facts. I have often ſeen them verified, to the no ſmall detriment of the manufacturer, and have as often regretted that ſo little attention ſhould be paid to the aſcertaining the proportion of alkali, &c.

Mr Kirwan of Dublin, whoſe active induſtry is now well known to all Europe, is the firſt who has engaged ſeriouſly in this inveſtigation; and the reſults of his labours are detailed in the 3d vol. of the Tranſactions of the Royal Iriſh Academy.

Having favourable opportunities, through the good ſervices of ſome of my friends, of procuring kelp from different quarters of Scotland, Ireland and Norway, I aſcertained the proportion of pure or carbonated alkali in each of them; in ſome by the teſt of ſulphat of argill, which is employed by Mr Kirwan; in others by uſing an acid of known ſtrength, the method recommended by Dr Black.

Table of the Proportion of Alkali contained in different kinds of Barilla and Kelp.

	In the 100lb.
Barilla from Alicant—good	23½lb.
Tenerif—bad	8 lb. 7 oz. 120 gr.
Kelp from Norway—indifferent	2 lb. 11 oz.
Shetland—indifferent	2 lb. 6 oz.
Iſland of Lewis—indifferent	2 lb. 11 oz.
Ibid—indifferent	2 lb. 6 oz.

Weſt Highlands—much damaged - -	1-3d of lb.
Arran	
Iſla—good - -	4 lb.
Mull—good -	$4\frac{1}{2}$ lb.
Morven—good -	$4\frac{1}{2}$ lb.
Iſland Skye—good	5 lb.
Leith ſhores	

In judging of the value of kelp, it is not ſufficient that we have aſcertained the proportion of ſoda; ſeveral other circumſtances muſt be attended to. In the firſt place, in judging of the value of a cargo, we muſt carefully examine its general appearance, which comprehends the ſize of the maſſes, the greater or leſs quantity of mixed ſtony matter, the degree of compactneſs, the proportion of diffuſed charcoal, the cauſticity, its wetneſs or dryneſs, &c. We then take pieces as different as poſſible from each other, and as expreſſive of the character of the whole as we can, pound them, and take any determinate quantity, as an ounce, and aſcertain the proportion of ſoda, which being done, will afford us as juſt an idea of its value, as we can obtain from the nature of circumſtances. I have here ſubjoined the character of one ſpecies of kelp from Norway, which will give a better idea of external characters, &c. than could be done otherwiſe.

KELP FROM NORWAY.

This cargo was compoſed of pieces generally about half a hundred weight, and little mixed with any in a ſmall powdery ſtate; a conſiderable portion of ſtony matter was mixed, not in the form of gravel or ſand, but in large maſſes, which were either in the centre of great pieces of kelp, or were themſelves only covered with a coating of it.

Texture—Looſe; veſiculæ large and numerous, often filled with charcoal; in other ſpecimens, texture more compact, veſiculæ ſmall, leſs numerous, not containing charcoal.

N.B. The circumſtance of the veſiculæ being more or leſs numerous, or large, and the preſence of charcoal, all ſhow whether or not the fuci have been well burnt.

Colour—Dirty blue, or grey, but when more compact, approaching to the green.

Odour—When breathed upon, emits a faint ſulphurous odour.

Taſte—Pretty cauſtic, mixed with that of ſea ſalt.

Hardneſs—Eaſily ſcraped with a knife, often yielding to the knife; but with a conſiderable degree of toughneſs.

Dryneſs—Was ſo dry as to have effloreſcent cryſtals upon its ſurface.

Proportion of Alkali—100 lb. contained 2 lb. 6 oz. of ſoda.

COAL.

As notwithſtanding many unfavourable ſymptoms, it is not improbable that coal may yet be found in Arran; and as the low eaſt part of the Mainland of Shetland does not preſent any very unfavourable appearances; on theſe accounts, I will now mention, in as few words as poſſible, the ſymptoms and methods of detecting the preſence of ſuch ſtrata or veins.*

1. Coal is never found in primitive mountains.

2. Although ſandſtone abounds in any country,

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* The exiſtence of coal veins is now well proved; and from what we know, it appears, that when coal is found in ſuch ſituations, it is but in ſmall quantity. At Caſtle Leod, in the Highlands, there are intereſting appearances of this kind, and I believe alſo in the iſland of Mull.

we are not to expect coal, particularly in the red-ſandſtone diſtricts. This obſervation is only applicable to Scotland, according to Dr Walker.

3. If the ſandſtone be of a white colour, and have interpoſed black bituminous or carbonaceous matters, this may be reckoned a good ſymptom, as this ſpecies is only to be found in the coal countries.

4. If bituminous ſhale, ſchiefer thon, and limeſtone make their appearance, it is a further proof of the vicinity of coal.

5. We ſhould examine the nature of the ſprings, whether their direction be in that of the ſtrata, and particularly whether they contain ſmall fragments of coal. This ſymptom is often of conſiderable importance.

6. Having obſerved ſuch ſtrata as render the preſence of coal probable, we muſt next endeavour to diſcover its actual exiſtence. To do this, we muſt examine the beds and banks of rivulets; if ſmall pieces of coal are detected, we are pretty

certain of the exiſtence of coal higher up. We ſhould alſo examine the ſoil, as it is thrown up by moles, or the plough; if ſmall angular pieces of coal appear, it may make us ſuſpect its preſence. This mark, however, is not to be depended upon, unleſs we be certain, that no coaly matter has been accidentally mixed in manuring the ground, or in burning limeſtone. Ditches are alſo to be examined; for in forming theſe, we often cut through the thin covering of gravel and ſand, which conceals the crop from our view. We often obſerve here and there ſmall pieces of coal immerſed in the argillaceous breccia, which is obſerved in coal countries; but a good deal of caution is neceſſary in drawing concluſions from this appearance, when we recollect that this breccia is formed of the debris of all the mountains in an extenſive diſtrict. We often obſerve a ſooty-like matter ſpread upon levels, or on the declivity of hills; this is generally formed by the decompoſition of coal, and is reckoned a very good ſymptom of its vicinity.

Having, from ſome of the preceding circumſtances, determined the probable exiſtence of coal, in a certain diſtrict, we muſt now endeavour to diſcover the crop, or outburſt of the ſtrata. This is a matter of much difficulty, and requires particular attention to the diſpoſition of the fragments of coal, &c. If they be found upon the banks or bed of a rivulet, we muſt ſearch higher up, to diſcover the crop of the ſtratum; if the appearances of ſooty matter, &c. preſent themſelves, it is very neceſſary to remark, whether they lie upon a declivity, or a plain; as inattention to theſe circumſtances has often been the cauſe of great diſappointment and expence to the coal miner, in overſhooting the ſtratum, that is, in cutting beyond its real ſituation. Upon a declivity, we know, that the decompoſing and looſe matter of a crop, will naturally ſpread downwards, in proportion to the greater or leſs elevation of the pente. On this account, wherever appearances of coal occur upon a declivity, we muſt always trace the debris upwards, when we will find it increaſe in depth, towards the crop, and the coal is leſs and leſs decompoſed, as we approach nearer to it. On the other hand, where the ſooty matter occurs upon a plain, we invariably find it thicker, and far leſs ſpread, than upon a declivity; and what is of conſequence, it ſpreads often in a direction contrary to the riſe of the ſtrata. This ſhows us the neceſſity of a knowledge of the elevation and the direction of the ſtrata; for without this, we cannot ſearch with ſo much certainty, for the real poſition of the coal.

8. Having now diſcovered the direction in which we are to work for the detection of the ſtratum, we either dig forward towards its dip, or follow the fragments of coal, by a trench, until we have the ſtratum fairly under our eye. Having diſcovered the ſtratum, we can now judge of its thickneſs, and value. The firſt is determined by digging through the rock until we find the pavement. Its value is aſcertained from the following circumſtances.

1ſt. Its general appearance, whether it be more or leſs mixed with ſtony matter, or if there be laminæ, of bituminous ſhale, or ſandſtone, dividing it into ſtratulæ, or if it contains much pyrites, or ſulphur of iron.

2dly, To theſe may be added the moſt certain teſts, that of chemical analyſis, in which we are certain of the proportion of carbon, bitumen and aſhes*.

Mr Kirwan, in the ſecond vol. of his Mineralogy, has given us an excellent plan for aſcertaining the proportions of carbon, bitumen, and aſhes in coal, and has added an intereſting table of the compoſition of ſeveral different ſpecies.

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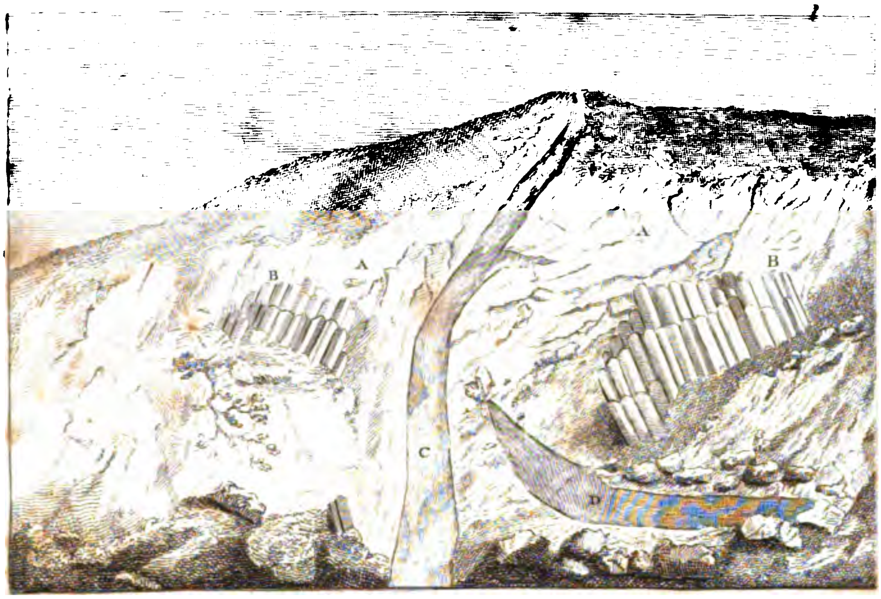
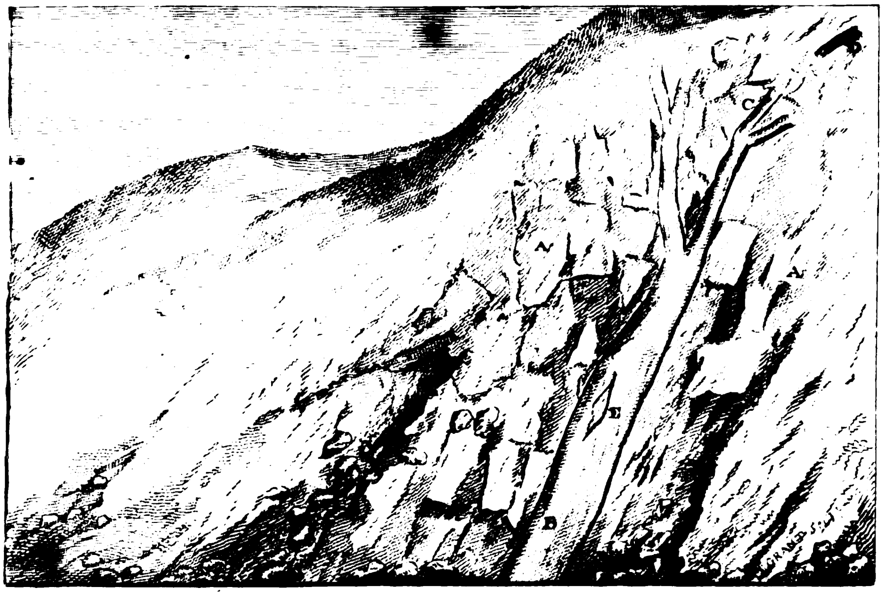
* Sometimes the coal, near the roof, burns well, but often it is uſeleſs, and it is imagined by miners, that the deeper the coal, the better.

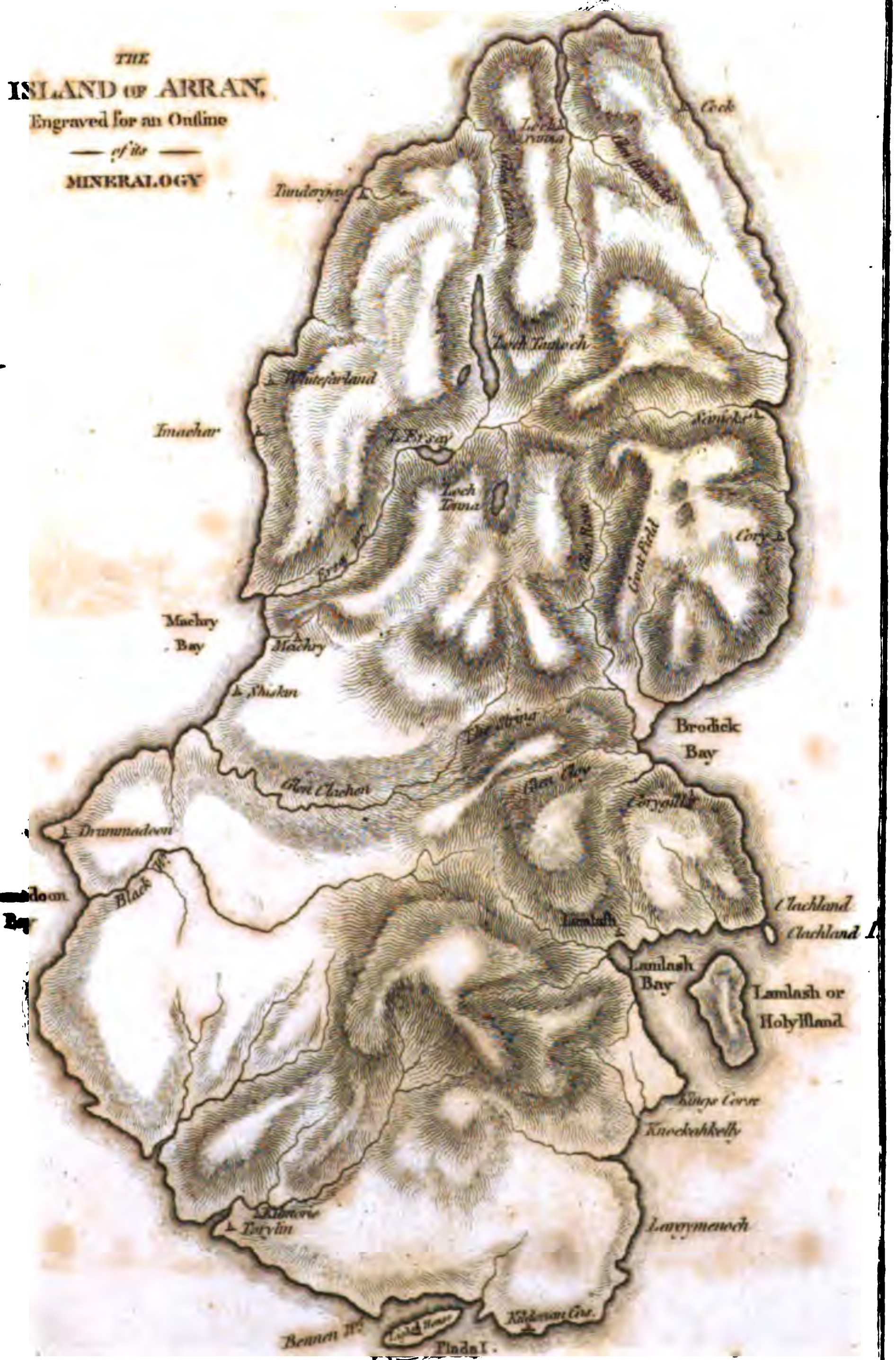
FINIS.

NORTH SIDE OF GLENCLOY.

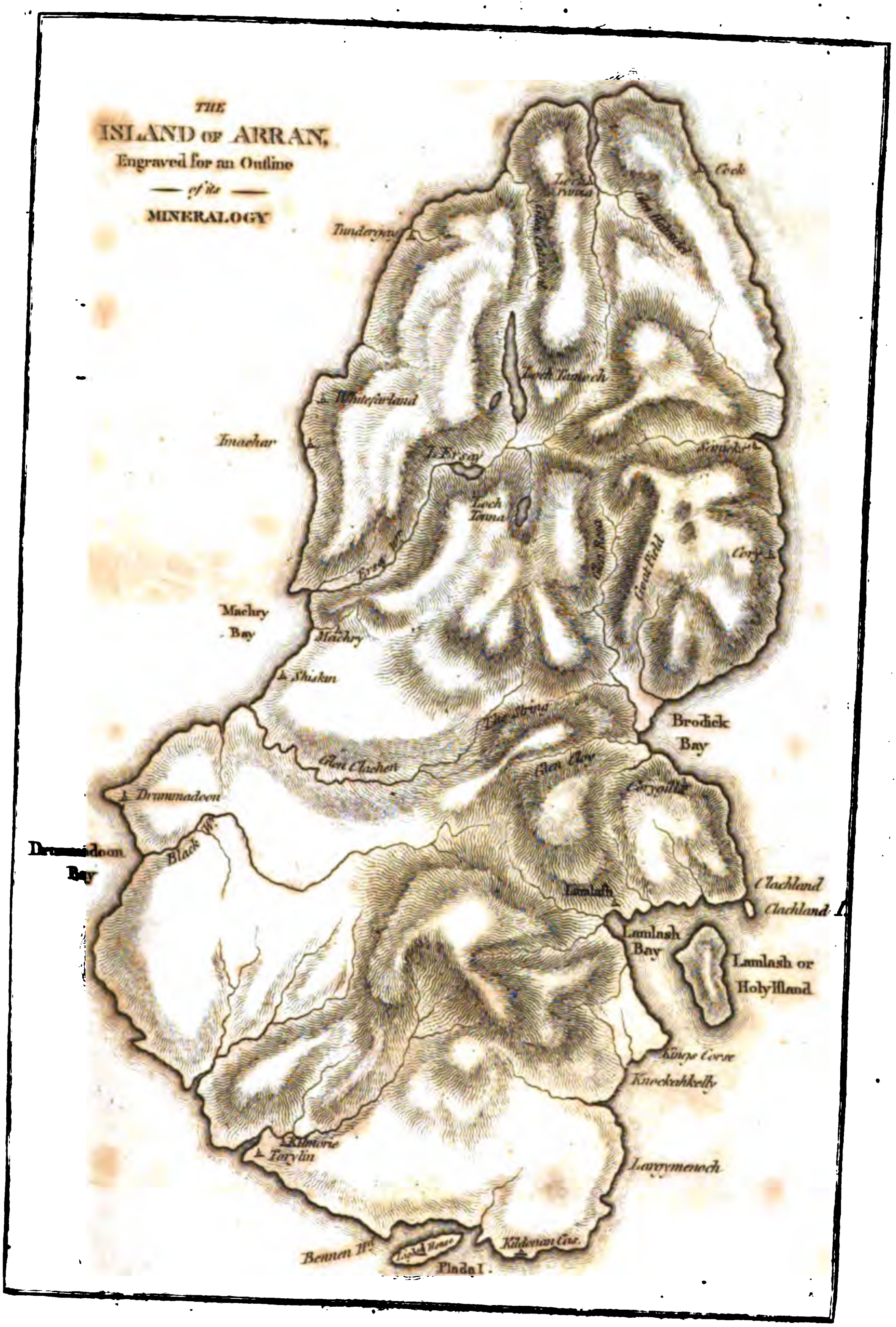


EAST SIDE OF GLEN ROSA.





THE
ISLAND OF ARRAN,
Engraved for an Outline
— of its —
MINERALOGY



THE
ISLAND OF ARRAN,
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